THIRTY-FIRST ANNUAL REPORT
OF THE
ONTARIO DEPARTMENT OF MINES
1922

PARTS III TO X

ack'd.

Feb. [illegible]

Rec'd [illegible]

[illegible]

Digitized by the Internet Archive
in 2011 with funding from
University of Toronto

http://www.archive.org/details/annualreport192202onta

Ont
M
Ontario. Mines, Dep. of

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES
THOS. W. GIBSON, DEPUTY MINISTER

THIRTY-FIRST ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXI, PART III, 1922 — Pr. 10
(+ 5 maps in pocket.)

Blanche River Area

By

A. G. Burrows and P. E. Hopkins

19456
28.2.25

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed by Clarkson W. James, Printer to the King's Most Excellent Majesty
1922

TN
27
O5-33
1922
pt 3-10
cop 2

Printed by
THE RYERSON PRESS

CONTENTS

Vol. XXXI, Part III.

PAGE
Introduction 1
Previous work 2
Topography 3
Geology 3
    Keewatin 4
    Pre-Algoman 6
    Algoman 6
    Cobalt Series 6
    Keweenawan 7
    Paleozoic 8
    Pleistocene 9
Gold 10
    Bryce Township 10
    Dack Township 12
    Chamberlain Township 12
Silver 13
    Cane Township 13
    Auld Township 14
    Casey Township 15
    Ingram Township 16
    Bayly Township 16
    Mulligan and Pense Townships 16
Brick Industry 16
Limestone 17
Quartzite 19
Peat Bog 19
Sand and Gravel 19
Water Supply 20
Hydro-Electric Power 20

ILLUSTRATIONS

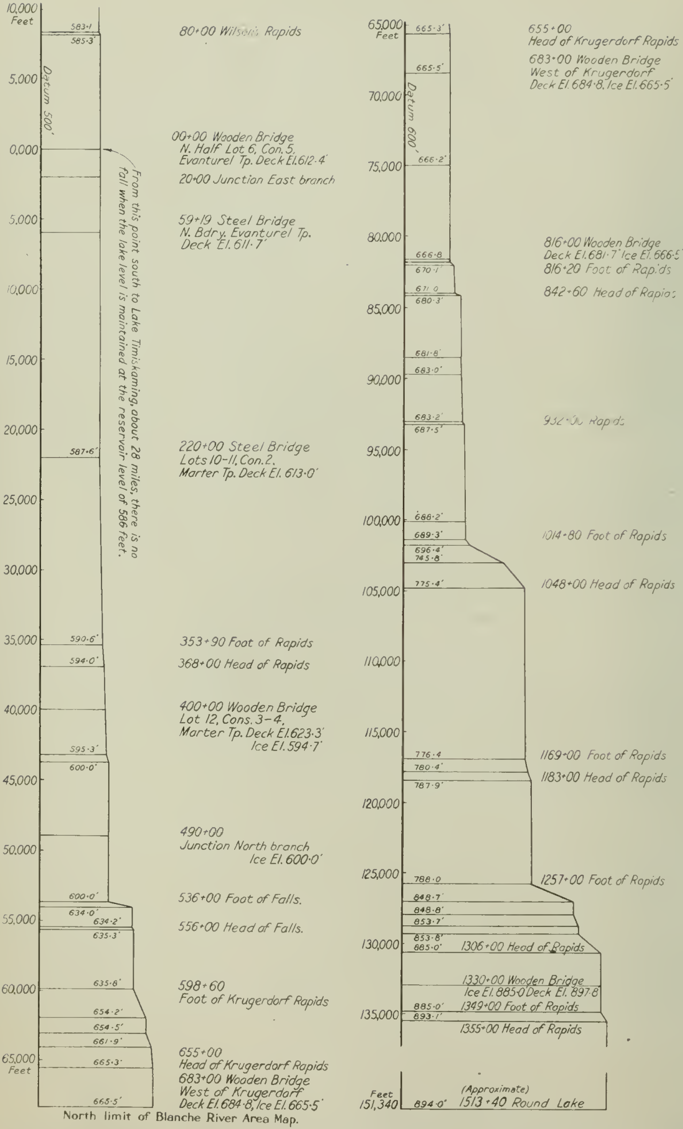
PAGE
Gold bearing shear zone in andesite, Borgford claim, Bryce township 10
Pit on Borgford claim showing two rusty weathering gold bearing bands 11
Limestone (Lockport) cliffs at Dawson point, Lake Timiskaming 17
Lime kiln on lot 1, concession I, Armstrong township 18
Outcrop of Silurian (Lockport) limestone at Dawson point 19

SKETCH MAPS AND DIAGRAMS

PAGE
Profile of a portion (30½ miles) of the Blanche river, scale 2 miles to the inch iv
Key map showing the location of the Blanche River area 1
Cross-section showing the relationship of rocks in Bryce township 10

GEOLOGICALLY COLOURED MAP

No. 31b.—Blanche River Area, District of Timiskaming, scale one mile to the inch
(In pocket on inside of back cover)



Profile of a portion (30½ miles) of the Blanche river, horizontal scale 2 miles (10,560 feet) to 1 inch. Altitudes, determined in March, 1922, by the T. & N. O. Ry., are referred to sea-level.

BLANCHE RIVER AREA

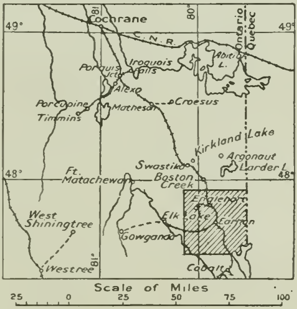
By

A. G. Burrows and P. E. Hopkins

Introduction

This report deals with an area which lies to the north and northwest of Lake Timiskaming, and which is drained largely by the Blanche river and its numerous tributaries. The area includes a block of twenty-five townships, approximately thirty miles square, lying between the Cobalt silver area on the south, and the Boston-Skead gold area on the north. The Ontario-Quebec boundary forms the east limit of the map-sheet; the south boundary is at 47° 30′ north latitude.

Much of the area consists of clay, which is being rapidly cleared for agricultural purposes, the land around Liskeard[1] having been settled prior to 1900. The Temiskaming and Northern Ontario Railway, with branch lines to Elk Lake and Charlton, passes through it. There are good wagon roads and rural telephone lines in many of the townships. Approximately three million ounces of silver have been mined from the Casey-Cobalt mine in Casey township. Rich silver showings have also been found in Cane and Auld townships, and there are indications of silver in the vicinity of Wendigo lake. Prospecting for gold has been carried on in Bryce, Dack, Marter and other townships.



Key map showing the location of the Blanche River Area in reference to the mineral areas of Timiskaming and Cochrane districts.

Accompanying this report is a coloured geological map of the area, on a scale of one mile to the inch, on which are shown the rock outcrops, clay and sand tracts, wagon roads, roads under construction, and many other features.

Most of the field work was done in the summer of 1921, when H. T. Leslie, A. R. Clarke, J. A. Wedge and D. Kearney acted as efficient assistants. The field work was completed in May, 1922, with the assistance of K. B. Heisey and W. Greenwood.

The assays and analyses were made by W. K. McNeill and T. E. Rothwell of the Provincial Assay Office.

---

[1] The name "New Liskeard" is commonly used. In this report the ruling of the Geographic Board of Canada has been observed.

Previous Work

Lake Timiskaming and other geographical features in the area were known to the French as early as 1632. During recent years exploratory trips were made through the area by W. McOuat, W. G. Miller, W. A. Parks and others; however, only a limited portion of the Blanche River sheet has been previously mapped. Considerable geological work has been done in the neighbouring areas of Cobalt, Montreal River and the townships shown on the Boston-Skead map. Following the discoveries of silver ore at Cobalt, a possible silver-producing area was located by prospectors in several townships around Wendigo lake, where the Nipissing diabase was found to outcrop and veins carrying cobalt bloom were found. Portions of the townships of Bayly, Mulligan, Ingram and Pense were geologically mapped by R. E. Hore in 1908.[1] The townships of Casey and Harris were also partially mapped by Mr. Hore in the same year, following a discovery of native silver on the Bushnell property, afterwards known as the Casey-Cobalt mine, in the south part of Casey township.

Native silver was discovered in the townships of Auld and Cane a few years ago, and parts of these townships were mapped in 1920 by A. G. Burrows.

A part of the central portion of the area, extending northwesterly from the north end of Lake Timiskaming, for a distance of twenty-eight miles and for a width of nine miles, is largely covered with Pleistocene deposits of stratified clay,[2] with a few scattered outcrops of Paleozoic rocks. The Paleozoic rocks of Niagara age were recognized as early as 1845, by Sir William Logan around the north end of Lake Timiskaming, and were described by A. E. Barlow in 1897. The Paleozoic rocks near the north end of the lake are shown in the 1910 edition of the map of Cobalt, published by the Ontario Department of Mines.

In 1915, M. Y. Williams recognized the Ordovician (Black River) formation as occurring to the west of Haileybury, fragments of which were found along the shore of the lake by Logan.

In 1916, G. S. Hume[3] mapped the Paleozoic rocks to the northwest of Lake Timiskaming. As the area is largely covered by Pleistocene clay deposits, the records of drill holes in different localities were used by Mr. Hume in determining the distribution of these rocks.

Walter McOuat,[4] one of the earlier explorers, made a micrometer survey of Blanche river from Timiskaming to Round lake in 1872. The main part of the Blanche river flows through the area described in this report. For the first twenty-five miles of its course no rocks were exposed along the shores, after which rocks outcropped infrequently to Round lake. McOuat describes certain rocks as chlorite and hornblende schists and diorite.

W. G. Miller,[5] Provincial Geologist, in 1900, described the geology along the north and Abitibi branches of the Blanche river and Wendigo lake.

In 1904, W. A. Parks[6] made a geological examination along main canoe routes in the area together with some land traverses.

---

[1] Ont. Bur. Min. Reports, Vol. XIX, 1913, Part II, pp. 149-151.

[2] Ibid, Vol. XVIII, 1909, pp. 284-293, by A. P. Coleman.

[3] Paleozoic Rocks of Lake Timiskaming Area, Summary report, Geol. Surv. of Can., 1916, pp. 188-192.

[4] Report of an examination of the country between Lakes Timiskaming and Abitibi, Report of Progress, Geol. Surv. Canada, 1872-73, pp. 112-135.

[5] Lake Timiskaming to the Height of Land, Ont. Bur. Mines Report, Vol. XI, 1902, pp. 214-230.

[6] The Geology of a District from Lake Timiskaming Northward, Summary Report, Geol. Sur. Canada, 1904, pp. 198-225.

Topography

A marked characteristic of the region is the flat plain extending northwesterly from Lake Timiskaming. This is composed of Pleistocene clays and flat-lying Paleozoic rocks, and has an elevation of 630 to 820 feet. The clay plain has been deeply intersected by V-shaped valleys formed by the Wabi and Blanche rivers and their many tributaries, which empty into Lake Timiskaming. The Blanche river at Englehart has cut at least 100 feet into the plain. The streams have a turbid appearance due to finely-suspended clay particles. The Montreal river cuts across the southwest corner of the map-sheet. Long Lake, near Charlton, is the largest lake in the area. An arm of the clay plain extends southwesterly from Earlton, along which runs a branch line of the railway. This portion in part of Kerns, Henwood and Cane townships, consists of flat-lying pre-Cambrian quartzite. Around these flat areas, the country is hilly, due to the uneven erosion of the pre-Cambrian rocks, and has the general appearance of the pre-Cambrian topography throughout most of northern Ontario.

A plain of good agricultural land, from 200 to 250 feet higher than the Englehart-Liskeard plain, occurs in the vicinity of Charlton, in parts of Dack, Robillard, Beauchamp, Savard and Chamberlain townships. Hills of Keewatin lava and agglomerate rise 200 to 300 feet above this plain, near the boundary between Dack and Beauchamp townships. Some very marked ridges and hills occur in other portions of the area. High ridges of Nipissing diabase form striking features in Auld and Cane townships. The northeast part of the area, in the townships around Wendigo lake, is particularly rugged, some of the ridges being 300 feet above the lake. There are also some pronounced conical hills of Keewatin diabase in Brethour township. In the township of Beauchamp the chief features are the high morainic hills and ridges of sand and gravel which form some of the highest points in the area. Other sand areas accur in northeast Marter and in southwest Hudson township. A prominent sand and boulder ridge extends in a northwest-southeast direction across Armstrong, Hilliard and Harley townships.

Geology

There is a wide range of rocks in the area, including many members of the pre-Cambrian, varying in age from much altered lavas of the Keewatin to well-preserved Keweenawan diabase, and in addition areas of fossiliferous dolomite of early Paleozoic age. It is unusual to see formations that are younger than the pre-Cambrian represented on maps of portions of northern Ontario. The Keewatin, Algoman, Animikean, Keweenawan and Silurian are all prominently shown on the accompanying map. The pre-Cambrian rocks are similar to those described in reports on surrounding areas.

The geological divisions are shown in the table of formations which follows, the oldest being placed at the bottom.

TABLE OF FORMATIONS

PLEISTOCENE
GLACIAL AND RECENT—
Peat bog.
Sand, gravel, sandy loam and boulders.
Stratified clay, boulder clay, clay loam, sandy clay.

PALEOZOIC
SILURIAN—
Lockport dolomite and sandstone.
Cataract limestone and impure shales.

ORDOVICIAN—
Trenton limestone.

Unconformity

PRE-CAMBRIAN

KEWEENAWAN—

Diabase dikes and sills, granophyre.

Intrusive Contact

ANIMIKEAN (COBALT SERIES)—

Quartzite.
Conglomerate, arkose, greywacké and slate.

Unconformity

LAURENTIAN OR ALGOMAN—

Quartz-porphyry, aplite and felsite dikes.
Hornblende-biotite granite, syenite and gneiss.

Intrusive Contact

PRE-ALGOMAN (?)—

Diabase.

Intrusive Contact

KEEWATIN—

Rhyolite, andesite and dacite.
Amygdaloidal and ellipsoidal basalt, agglomerate, diabase, hornblende and chlorite schist.
Mica schist.

Keewatin

The Keewatin occurs prominently in the west part of the area, namely, in the townships of Robillard, Bryce, Dack and Beauchamp. Similar rocks occur in the townships of Marter and Bayly, while a few scattered outcrops of Keewatin are found near the Ontario-Quebec boundary.

Basalt and Andesite.—The Keewatin consists principally of altered basic lavas which were originally basalt. These are quite dark-coloured, and frequently show the pillow structure so characteristic of basic lava flows of this age. The lavas in Robillard township are chiefly dark-coloured with pillow structures and frequent amygdules, and in places are altered to hornblende and chlorite schists. The basic lavas extend southerly into the north part of Bryce township, while farther south they become lighter-coloured, approaching andesite in composition.

With the andesite there is a light, greenish-grey rock which has the composition of dacite, or possibly rhyolite. A great part of Bryce is covered by the lighter-coloured andesitic and dacitic rocks. The pillow structure was observed in andesite on lot 2 along the line between concessions III. and IV. The rock has a slightly porphyritic texture, showing phenocrysts of plagioclase and smaller crystals of biotite altered to chlorite, while a second generation of plagioclase is shown in the groundmass. In places the andesite has an amygdaloidal structure.

The dacite shows phenocrysts of quartz as well as plagioclase and is lighter-coloured than the andesite. Much of the rock has an ash grey colour on the weathered surface. In lots 10 and 11, concession IV., Bryce township, there are grey feldspar porphyry masses which may be differentiation phases from the andesite magma.

The lavas are altered in places to schist with a strike approximately N 70° W, and dip 60 deg. to 80 deg. north.

With the light-coloured lavas there are bands of agglomerate breccia or tuff-like deposits of material similar to the lavas, which make up a great part of the light coloured rock. These occur in lots 9 and 10, concessions II and III and in lot 5, concession VI, Bryce, and on the boundary between Beauchamp and Dack townships. Ash rocks are likewise associated with the more basic lavas on the boundary line between Dack and Chamberlain townships.

The composition of the andesite and dacite is shown in the following tables:

(1) Lot 11, line between concessions III and IV, Bryce.
(2) Lot 10, concession IV, Bryce; Analysts, W. K. McNeill and T. E. Rothwell.

	(1) Andesite per cent.	(2) Dacite per cent.
Silica	61.56	70.68
Alumina	17.96	15.79
Ferrous Oxide	4.95	4.75
Ferric Oxide	1.01	1.17
Lime	3.86	1.17
Magnesia	2.58	0.94
Potash	0.42	2.01
Soda	4.16	3.05
Carbon Dioxide	0.94	1.02
Water	2.82	2.05

Some shear zones carrying values in gold occur in the light-coloured volcanics in Bryce township.

The andesite which covers nearly all the southwest part of Skead township extends southerly into Bayly, most of the northwest part of the latter township being covered by andesite, with the exception of some diabase dikes and a little conglomerate near Wendigo lake. With the andesite is a breccia which is made up of fragments of the andesite. This type of rock occurs in lot 3 concession IV, Bayly township. No gold deposits were seen in Bayly township, however the andesite of Skead township is known to contain gold-bearing veins.[1]

Mica Schist.—There are several outcrops of mica schist in the eastern part of the area. They occur along the boundary line between Ontario and Quebec, about two miles north of the southeast corner of Mulligan township. Mica schist occupies a large part of the southeast portion of Pense township and also a part of Brethour. Similar rock occurs in small patches in Casey township.

The rock is a fine-grained biotite schist, containing numerous quartz grains. It is grey to black in colour, depending on the proportion of biotite, and often has a rusty surface due to the oxidation of disseminated iron pyrites. In places there is a definite banding or stratification, indicating an origin from a quartzose sediment. Irregular lenses of quartz occur in the schist in the direction of schistosity which is generally east and west. The rocks usually dip to the north at about 80 deg. A few narrow dikes of diabase intrude the schist.

From the description given by Morley E. Wilson [2] of the Pontiac series which he found to occur in a large area in Quebec to the east of Larder lake, it is evident that the rock above described is similar to the Pontiac schist. Wilson did not find any relationship between the mica schist and the Keewatin greenstones, and consequently placed the schist in a separate series. Some of the greenstone in Pense township does not appear so highly metamorphosed as the mica schist, but the rocks were not observed in contact. It has been thought advisable to group the mica schist with the Keewatin rocks on the accompanying map. In the southeast part of Pense township the mica schist has been intruded by coarse hornblende syenite. The mica schists resemble the Couchiching of western Ontario.

---

[1] Boston-Skead Gold Area by A. G. Burrows and P. E. Hopkins, Ont. Dept. of Mines Report, Vol. XXX, 1921, Pt. 6.

[2] Larder Lake District. Geo. Sur. Can. Memoir, 17E, p. 27.

Pre-Algoman ?

Cutting the andesite to the north of Wendigo lake on lots 7 and 8, concession III, IV, and V, Bayly township, is a massive altered diabase which may be pre-Algoman in age. The rock is clearly intruded by a Keweenawan diabase dike, but its relationship with the other rocks is not known.

Algoman

Pink and grey biotite granites occur in several parts of the area. The largest volume is that which covers Savard and parts of Bryce, Robillard and Chamberlain townships. The granite is part of a larger area that extends northerly in Pacaud and Marquis townships, and westerly towards Elk lake. The batholith of biotite granite is generally massive in structure, but near the contact with older rocks it may be gneissoid. It is pink to grey in colour, and frequently shows spots of quartz, stained a bright red, greatly resembling garnet in appearance. The chief constituents are quartz, orthoclase, plagioclase, biotite and augite, with small amounts of apatite and rutile.

A smaller mass of pink biotite granite outcrops in the east part of Mulligan township, extending easterly into Quebec.

A fine-grained white-weathering granite, or aplite, intrudes mica schist on lot 9, concession III, Pense township. In lot 11, concesion I of the same township the mica schist is intruded by a coarse red hornblende syenite.

Grey granite and gneiss occur on lots 10 and 11, concession II, Cane township. The area is small and has been exposed by erosion of overlying Cobalt series quartzite, and Nipissing diabase, which are the other rocks in the vicinity.

A few narrow quartz and feldspar-porphyry dikes are shown on portions of the accompanying map. Several narrow dikes occur in Keewatin schist between Charlton and Englehart near the periphery of a granite batholith. The porphyry occurs in larger volume in lots 10 and 11, concession III, Bryce township. At the latter locality the grey feldspar-porphyry may be a differentiation phase of the adjoining andesite; the porphyry also contains narrow gold-bearing veins. Somewhat similar porphyry occurs with the andesite in Bayly township. A quartz-porphyry dike occurs on the west boundary of Bryce township.

Cobalt Series

The series of sedimentary rocks occurs prominently in the east and southwest parts of the area. Around Wendigo lake, there are ridges of greywacké, quartzite and conglomerate, with which is associated the Nipissing diabase forming some of the highest points in the area. The sediments in the southwest part are largely reddish quartzite and arkose, which form the latest rocks of the Cobalt series. The quartzite is in comparatively low ridges outcropping through the clay and sand in the townships of Cane, Henwood, Auld and Lundy. In the township of Bryce there are scattered outcrops of conglomerate and reddish slate like greywacké which overlie the Keewatin schists and are intruded by the Nipissing diabase. The latter sediments are thin remnants along the margin of the large area of Cobalt series lying to the south.

Where exposed, the series is very little disturbed, having the nearly horizontal attitude characteristic of most of the Cobalt series which has been mapped over several hundred square miles of country to the south, southwest and west. To the west of Wendigo lake some of the boulders in the conglomerate are ten inches across.

A number of contacts with the older rocks were observed, some of the best being in Bryce township where numerous patches of conglomerate overlie the basalt, andesite and rhyolite, the old surface of the Keewatin on which the sediments were laid down, being much like that of to-day. Some of these small patches of conglomerate were seen in lot 5, concession VI, Bryce township, four miles from the main mass of sediments to the south. In the northeast corner of Mulligan township the conglomerate contains numerous grey, medium-grained biotite granite pebbles derived from the underlying granite in the immediate vicinity.

The order of deposition of the members of the Cobalt series in Bryce and Cane townships from the oldest to the youngest is as follows: conglomerate, banded reddish slate-like greywacké with thin beds of conglomerate, quartzite and arkose.

Keweenawan

The Keweenawan diabase, which has such a wide distribution in northern Ontario and which is known to be associated with the silver deposits of Cobalt and elsewhere, occurs in various parts of this area, particularly in the northeast and southwest. The country round Wendigo lake is very rocky and prominent ridges of diabase are found in the townships of Bayly, Mulligan, Pense and Ingram in the vicinity of the lake. Scattered ridges and hills of diabase outcrop through the heavy mantle of clay or sand southerly to Casey and Harris townships. In the southwest part there are ridges of diabase in Auld, Cane, Bryce and Lundy townships, while near Cobalt, in Hudson and Dymond townships, the diabase is also found. A number of relationships were observed in the field which confirmed the previous information regarding the sill form of the diabase. The best contacts were found in the township of Bryce, where both footwall and hanging-wall conditions occur, and a small area of diabase was seen from which the overlying rocks had been eroded, exposing the top of the sill. These features were observed on lots 8 and 9, concession II, Bryce township. The relationships between the diabase sill and the older rocks in the locality are shown on the accompanying cross-section. Similar structures occur in Auld and Cane townships, and are referred to in a previous report. R. E. Hore refers to the sill-like character of the diabase in his description of the occurrence near Wendigo lake. He states: "At the foot of cliffs of diabase, the igneous rock is seen to overlie horizontally bedded, slaty greywacké. At the west end of Lake Wendigo the slate dips slightly to the south under diabase. The cooling of the igneous sheet has produced vertical cylindrical columns. These are often well exposed in the ridge north of Ingram township, where columns twenty to thirty feet in diameter form the vertical cliffs, while wide cracks mark out the continuation of the column boundary."[1] The top of the diabase sill may also be seen in lot

---

[1] Ont. Bur. Min. Report, Vol. XIX, 1913, Part II. "Area South of Lake Wendigo."

10, concession III, Kerns township, and the bottom of the sill in lot 2, concession I and lot 1, concession IV of Hudson township.

Normally the diabase has the dark greyish to greenish colour characteristic of the major part of the sill in northern Ontario which has been described by Knight and other writers in earlier reports.

The typical diabase contains dark-coloured plagioclase, brown augite, a little biotite, and usually a little quartz intergrown with feldspar, also magnetite or ilmenite as accessory minerals.

A red rock, or granophyre, is found in minor quantity, particularly in the southwest part of Cane township, and is probably associated with the diabase as at Gowganda. The neighbouring rock in this locality is a feldspathic quartzite, and it is likely that some of the red rock has been formed by assimilation of the quartzite by the diabase, since it is difficult to distinguish the two rocks when found in the same outcrop. Granophyre also occurs in lot 9, concession III, Kerns township.

In places the diabase occurs as dikes. At Kenabeek station the contact between the diabase and quartzite appears to be vertical.

Considerable cobalt bloom occurs in the diabase in parts of Pense, Mulligan and Ingram townships. Promising silver-bearing veins occur in the upper part of the diabase sill in Cane and Auld townships. Much silver has been produced at the Casey-Cobalt mine in Casey township, the ore coming from sediments which were probably overlain by diabase.

Paleozoic

The latest report on the Paleozoic rocks of Timiskaming is by G. S. Hume[1] who mapped the formations in 1916. A large area of Ordovician and Silurian has been preserved by faulting. The strong NW-SE fault to the northwest of New Liskeard was first recognized by W. G. Miller.[2] The fault scarp, which is the continuation of the west shore of Lake Timiskaming, has been traced by Hume for 12 miles to the north part of Kerns township where the ridge flattens.

Hume classifies the Paleozoic rocks into an upper division, Silurian, consisting of Lockport and Cataract formations, and a lower division, Ordovician, consisting of Black River-Trenton. In 1915 M. Y. Williams[3] recognized the limestone on the ridge to the west of Haileybury as Ordovician, similar rock occurring to the west of Liskeard. The Ordovician formations here are on the west or upthrow side of the fault. Most of the exposures of dolomite to the east of the fault are referred by Hume to the Lockport, while the Cataract is exposed below the Lockport at Dawson point, and outcrops at the falls two miles south of Englehart. Hume also recognizes a thin band of Cataract extending northwesterly from the east side of Dawson point to Englehart. To the east of this, the same author has mapped a band of Ordovician extending to the pre-Cambrian rocks near the Blanche river.

The limestone of the area has been used for building purposes and for producing lime; also in connection with the paper sulphite plant at Iroquois Falls.

---

[1] Paleozoic Rocks of Lake Timiskaming Area, Summary Report, G.S.C., 1916, pp. 188-192, and accompanying map.

[2] Ont. Bur. Min. Reports, Vol. XIX, Part II, p. 120.

[3] The Ordovician Rocks of Lake Timiskaming. Museum Bulletin No. 17., Geo. Sur. Can.

Pleistocene

The greater part of the area is covered with Glacial and Recent deposits of unconsolidated material, stratified clay, sand, gravel, etc. The stratified clay is the most abundant of the superficial deposits, covering most of the townships extending northerly from Liskeard to beyond Englehart. The clay deposits are in a low area, which rises gradually to the north. The plain-like region broadens near Earlton, a narrow belt of clay extending southwesterly into Henwood and Cane townships, while easterly beyond the Blanche river in parts of Ingram, Hilliard and Brethour townships the clay contains much sand. To the west of Englehart there is a ridge of Keewatin greenstone and granite for a few miles, beyond which the clay continues over several townships around Charlton. Here, the underlying rocks are pre-Cambrian, and there are scattered hillocks and ridges of rock protruding from the soil. This clay area is 200 to 250 feet higher than the plain between Englehart and Earlton. The deposits of clay become scattered toward the north, consequently the rocky portions are more numerous and the country not so suitable for agriculture.

The presence of the large tillable clay area made possible the opening of a number of townships for settlement in past years. and the agricultural land available has been taken up by settlers. Many parts of the area have had well established communities for several years, the first settlements having been made near Liskeard over thirty years ago.

The elevation of the clay plain varies from 642 feet at Liskeard to 816 feet at Earlton, while at Englehart, farther north, it is only 677 feet.

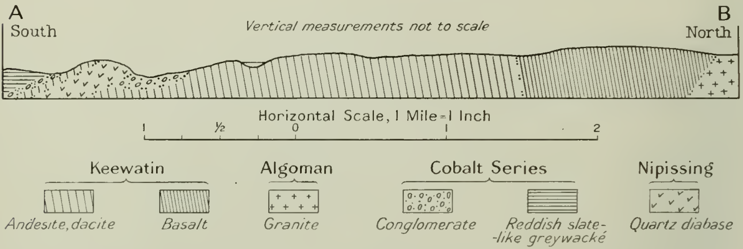
The clay deposits comprise alternating layers of dark and light-coloured materials, one-half an inch or over in thickness. which were formed in fairly deep waters. The deposits are in places from 100 to 200 feet in thickness. Red brick has been made from the clays at Liskeard. The clay in many parts of the area is overlain by sand, silt and gravel. Much of the eastern portion of Marter township is sand, which can be traced to the north for twenty-five miles. In the northeast part of the township the sand rises to a height of 100 feet. while farther south in the same township it gives way to a sandy loam which is covered in places by a thin covering of clay. Sand can be seen lying on stratified clay in a section of the river bank in lot 3. concession III, Marter township.

High morainic ridges occur in the west part of Beauchamp and the east part of Bryce in concessions II and III. These ridges are 100 to 150 feet above the plain. Several depressions represent old kettle lakes. many of which are now dry. To the south of the morainic ridges there is a broad sand plain, stretching southerly into the north parts of Cane and Henwood townships. which is possibly an outwash plain from a glacier.

A narrow sand-gravel-boulder ridge extends in a southeasterly direction for nine miles from lot 3, concession IV, Armstrong township to the southeast corner of Harley township. Silurian limestone outcrops at intervals along the ridge.

A glacial morainic deposit extends east of the Blanche river near Judge post-office in Casey township.

Where the rocks are exposed one often sees the glacial grooves and scratches, which strike from S. 30° E. to S. 50° E. astronomic.



Cross-Section on line A B (*See* map No. 31b) showing the relationship of rocks in Bryce township.

Gold

Bryce Township

Gold has been discovered on several lots in the township of Bryce. Since the township has been almost completely burned over, the rocky portions are well exposed for prospecting

Thelma.—Some years ago a shaft was sunk on the south half of lot 8, concession II by the Thelma Mining Company. The rock is schistose Keewatin, which is probably an altered andesite. This is cut by a quartz vein which, at the shaft,

Gold bearing shear zone, about 15 inches wide, in white weathering andesite. Borgford claim, Bryce township.

is 3 to 6 inches in width. It strikes N. 53° W. and has been traced about 200 feet with varying widths, showing small stringers running from the vein. The shaft could not be examined, but some of the vein material on the dump carries iron pyrites, copper pyrites, pyrrhotite and specularite, a sample of which gave no results in gold. It is reported, however, that some gold was obtained in samples from the vein. The Keewatin is here underlain by the Nipissing diabase sill.

Pit on the Borgford claim, north ½ lot 9, concession II, Bryce township, showing two rusty weathering gold bearing bands, each one foot in width.

Borgford.—During the summer of 1920 George Borgford of Elk Lake discovered some gold-bearing shear zones in the north parts of lots 9 and 10, concession II, Bryce township. Following this discovery a number of claims were staked in the vicinity. The rocks which carry the gold deposits are andesite, dacite and agglomerate, which are light greenish-grey in colour. These rocks are quite schistose in places, particularly in the vicinity of the veins. The ellipsoidal and amygdaloidal structure is not common, although numerous bomb-like inclusions were noted in the agglomerate. In some places the rock is quite porphyritic. The shear zones are recognized by the abundance of iron pyrites which is oxidized on the surface, staining the light-coloured rock a rusty brown. The rusty bands strike 20 degrees north of west, dip 80 degrees northerly, and are traceable at least 400 ft. The rusty streaks average about one foot in width, and one pit shows two of these three feet apart. They contain schist impregnated with iron pyrites, copper pyrites and quartz, together with some calcite, feldspar, pyrrhotite and zinc blende. A sample from a 12-foot pit near the east boundary gave $5.60 in gold per ton over a width of ten inches. Other samples from the same pit gave 80 cents and $2.00 per ton over narrow widths. Samples of the rock from the pit and adjacent to the rusty streaks gave no gold on assay.

Two samples from a pit 4½ chains southeast on lot 9, concession II gave 40 cents and 80 cents over widths of 12 inches, The three feet of rock between gave an assay of $1.20 per ton.

Quesnell.—Some years ago a 20-foot pit was sunk on an 18-inch white quartz vein in andesite in the southwest part of lot 10, concession II, Bryce township. The vein strikes approximately east and west and is traceable for 400 feet. Four men were trenching the vein in May, 1922. The quartz in places carries some iron and copper pyrites and the wall rock is scistose. Mr. Quesnell stated that a vein one quarter of a mile west gave encouraging values on assay.

S.W. ¼, S. ½, Lot 8, Con. III.—Some shallow pits have been sunk on bands of pyritous schist on this claim. A selected sample of the schist zone gave an assay of $2.40 per ton.

Lot 6, Con. VI.—A shaft was sunk in the basalt on some stringers of quartz carrying a little iron pyrites and pyrrhotite. No gold was shown on assay of several mineralized pieces of quartz from the dump.

Dack Township

A 100-foot inclined shaft has been sunk at a 30-foot falls on the Blanche river on the *Parker* claim in lot 7, concession IV. The shaft is sunk in a pronounced fault which strikes N. 30° E and dips 80° to the N. 60° W, the rocks being Keewatin serpentinous diabase and talc schist. Fragments of quartz, calcite, pyrite and chalcopyrite taken from the dump showed an absence of gold on analysis.

A narrow band of highly altered Keewatin schist occurs on the southeasterly periphery of a granite batholith extending in a northeasterly direction from the town of Charlton to lot 4, concession I, Chamberlain township. These lava schists, rusty carbonates and tuffs are intruded by a few small dikes of porphyry and lamprophyre, and contain occasional quartz veins. A shallow pit has been sunk in this zone on a porphyry dike with quartz veinlets near the hydro-electric power station at Charlton. A pit has also been sunk on a narrow quartz vein carrying iron pyrites on the *Scott* location, the south half of lot 6, concession V, Dack township. Considerable trenching has been done on the *McPherson* farms north parts of lots 4 and 5, concession VI, Dack township, exposing a quartz vein two to three feet in width and over a quarter of a mile in length. Two channel samples of quartz carrying iron pyrites, talc and dolomite from the vein gave on assay 40 cents and 80 cents in gold per ton.

Chamberlain Township

The McPherson vein extends northeasterly to the *Grant* location, lot 4, concession I, Chamberlain township. Several quartz veins can be seen in the railway rocks cuts on this lot; however, two samples, well mineralized with pyrite, showed no gold on assay.

Silver

Native silver, smaltite and niccolite and other related minerals have been found in several townships shown on the accompanying map. Silver ore has been shipped from the townships of Casey and Cane.

There are a number of veins of calcite and dikes of aplite in the townships of Auld and Cane that are silver-bearing. They occur toward the hanging-wall side, or upper part, of the diabase sill. The main outcrop of diabase is a long narrow section of a sill extending in a general north and south direction. The veins of calcite and dikes of aplite are approximately at right angles to the contact of the sill with the overlying quartzite, consequently the strike approaches east and west. A number of properties have been located on the diabase ridge, and the exploration of those along the easterly side has shown silver-bearing veins of promise.

Generally where an aplite dike is mineralized, it is accompanied by calcite and quartz veinlets, either irregularly in the dike or parallel to it. Veins in which aplite, quartz and calcite occur are more numerous than the ordinary silver-bearing calcite veins. The silver-bearing aplite dikes vary in width from an inch to 18 inches. The aplite is a differentiation from the diabase magma, sometimes occurring in dikes with well-defined walls. Again, the aplite may grade into the normal dark diabase and still have a dike-like structure, suggesting a segregation from the diabase magma in the process of cooling with consequent shrinkage, the more acid portion of the aplite being near the centre of the dike.

The quartz in the veins is later than the aplite, and the calcite the latest gangue mineral. Frequently there is a narrow band of quartz between the diabase, or aplite, and the calcite.

The smaltite usually accompanies the calcite, and native silver may occur as masses in the smaltite and calcite, or as sheets and scales in the quartz, aplite and diabase. Where veins of calcite occur in diabase or aplite, one portion may be replaced over its width with massive smaltite and silver, and thus show bunches or small shoots of high-grade along the vein, with adjacent parts containing little or no smaltite or silver.

Cane Township

Cane.—The Cane Silver Mines comprise three mining claims, M. R. 5227, 5251, 5276, in lot 2 in the second concession of Cane township. They are situated along the narrow ridge of diabase that extends from Auld to Cane.

A number of silver-bearing veins occur along the easterly side of the diabase ridge in proximity to the overlying quartzite, consequently they are in the upper part of the diabase sill. They are approximately at right angles to the contact, varying in strike from N. 70 deg. E. to S. 70 deg. E. Eight veins have been located and work was being done on three of them in the fall of 1920. Open cuts were made on veins Nos. 1, 2 and 8, and ore has been bagged from each of these. No. 1 was traced 175 feet, with strike N. 70 deg. E. and dip 80 deg. N., extending westward across the boundary to the next claim. This vein is aplitic in character, showing lenses of calcite, smaltite, niccolite and silver and some bismuth, varying in width up to four inches. There are also branching veins, in one place three in a width of four feet. There is some leaf silver as well in the diabase along the veins. One lens of high-grade ore that was mined was about three feet long, carrying massive smaltite studded with native silver. A sample of high-grade ore has the following partial composition: Co.—19.29; Ni.—3.67; As.—46.44 per cent.

An open cut was made on No. 2 vein, which contains two leads about two feet apart. Aplite is also the chief gangue of these veins, one showing a width of two or three inches, with streaks of high-grade silver ore about one-quarter to one-half inch thick, and forming a rib-like structure in the aplite. At times the high-grade ore runs diagonally across aplite. These high-grade streaks carry silver, smaltite and calcite. Some leaf silver is also found in the diabase near the veins.

No. 8 vein, on the northerly claim of the group, is also of aplitic dike character with an average width, where exposed by trenching, of 14 inches. One section of the dike for 20 feet shows an abundance of cobalt bloom on the surface. An open cut was made along this section, revealing lenses and impregnations of smaltite carrying native silver. The silver-bearing smaltite occurs irregularly, sometimes along the walls of the dike, sometimes running diagonally across the dike, and again as rounded nodular-like masses in the aplite. The aplite where it contains smaltite and silver is impregnated with calcite. A shaft was sunk on this vein, using hand steel, to a depth of 40 feet, the vein maintaining its width with ore similar to that found on the surface. Work was stopped in December. It is expected that a compressor plant will be installed at a later date when mining will be resumed. Previous to October 1, 1920, 100 sacks of ore weighing 3½ tons and assaying 402 ounces of silver per ton, were shipped from open cuts to the Cobalt Reduction Company. One hundred sacks in addition were taken from the open cuts and shaft before work ceased for the winter. J. J. Byrne is manager of the property.

Shepp.—The two principal claims of the group are M. R. 5279 and M. R. 5286, lying just northeast of the Cane Silver Mines. An aplite dike 8 inches wide and dipping 80 deg. N.E. crosses the line between the two claims; two shafts have been sunk to moderate depths and some trenching done. The southerly shaft was sunk at the junction of two aplite dikes 6 inches and 8 inches in width. The material on the dump shows some massive smaltite, partly altered to cobalt bloom, together with a little native silver. The exposure here somewhat resembles that at No. 8 vein at the Cane mine. At the time of examination the shafts were filled with water, but work was to be resumed in the spring of 1922, the intention being to sink to a depth of 100 feet and to cross-cut to the vein. The owning company is Ontario Solid Silver Mines, Limited.

Auld Township

Triangle.—The Triangle Silver Mines, situated in Auld township, consists of 1,000 acres, being part of lots 2 and 3 in the fifth and sixth concessions. Silver was discovered on the group in 1912, and this discovery is described by C. W. Knight[1] as follows:

> On the Hitchcock location, south half of lot 3, con. VI, there are a number of narrow east and west veins, in some of which native silver with some smaltite and bloom have been found. The wall rock of the veins is usually aplitic. On the westerly side of the easterly diabase ridge native silver occurs at two points in fairly coarse dendritic form. At the northerly exposure there is coarse-grained reddish aplite which is heavily stained with bloom. The aplite has more the character of a differentiation of the diabase than a clearly defined dike. At the other exposure where silver was seen, there is a grey aplite along one perpendicular surface of which there is native silver in dentritic form.

---

[1] Ont. Bur. Min., Vol. XIX, 1913, Part 2, p. 163.

Veins were later discovered on lot 2 lying to the east and near the contact with the quartzite. The group of claims was operated first as the Kenabeek Silver Mines, later re-organized as the Triangle Silver Mines. On lot 2, a tunnel has been driven westward on a fracture on the east side of a high diabase ridge. The principal work, however, has been on a series of veins, the principal one of which strikes N. 66 deg. E. and dips 80 deg. S. A shaft has been sunk to the 132-foot level, on the dip of the vein, and to the 182-foot level at a flatter angle. Drifting and cross-cutting have been done on the two levels, most of the work being on the upper level. A faulted zone, 10 feet to 12 feet in width and dipping flatly southward, was encountered at the first level.

The calcite veins on which underground work was done carry segregations of native silver, smaltite and niccolite. The veins vary from an inch to six inches in width, while some heavy sheet silver is occasionally encountered in the wall rock. A small quantity of ore has been raised from the mine, but no shipments have been made. W. R. Hitchcock is managing director and W. H. Jeffrey mine manager.

Bradley-Donaldson.—The Bradley-Donaldson property includes the south half of lot 5, Con. IV., Auld. It is situated on the west side of Lepha lake, along the westerly shore of which is a high diabase ridge sloping steeply to the lake. No work has been done for several years, and the camp buildings are dismantled. A tunnel was run westward into the ridge on a calcite vein near the south boundary of the property, and it is stated that some native silver was obtained from the workings now filled with water. Fragments from the dump show a banded structure in the vein, which is composed chiefly of grey calcite with narrow ribbons of quartz. The structure indicates a replacement type of vein along a fracture in the diabase. In this locality the diabase dips steeply beneath the quartzite, and the workings are near the upper contact.

Casey Township

Casey-Cobalt Mine.—The property is situated on the southeast quarter of the south half of lot 5, concession I, Casey township, about 10 miles northeast of the town of Liskeard. The mine was operated from 1908 to 1919, during which time it produced 2,946,512 oz. silver and paid $203,249.33 in dividends. The property has been described in the report on "The Cobalt-Nickel-Arsenides and Silver Deposits of Temiskaming."[1] The producing veins were in rocks of the Cobalt series. C. W. Knight states that the shaft passed through 240 feet of conglomerate greywacké and greywacké slate, after which it met with an old complex consisting largely of lamprophyre and fine-grained greenstone. About a quarter of a mile northerly from the shaft the Nipissing diabase was seen resting on the sediments of the Cobalt series and dipping apparently to the east. It is probable that the diabase sill originally covered all the rocks on the present hill, it having now been largely eroded. Conditions are therefore similar to those at Cobalt where the greater part of the silver mined has been from veins in the Cobalt series beneath the Nipissing diabase sill.

Casey Mountain.—This property comprises portions of lots 6 in the second and third concessions of Casey township. On the location is a large diabase outcrop surrounded for some distance by clay and sand. According to the general manager, R. G. Williamson, No. 1 shaft is 415 feet deep with 90 feet of drifting at the 50-ft. level, a short drift at the 100-ft. level, a cross-cut at the 325-ft. level and 116 feet of cross-cutting at the lowest level. Some diamond drilling has also been done on the lower levels. The No. 1 shaft showed 140 feet of conglomerate between the diabase capping and the underlying Keewatin. No. 2 shaft to the north is 245 feet deep. Seventeen men were employed at the property in October, 1921.

---

[1] Ont. Bur. Min. Reports, Vol. XIX, Part 2, p. 148.

Ingram Township

The township of Ingram is for the greater part covered with drift deposits, most of the township being suitable for agricultural purposes. There is a small amount of diabase exposed in the northern part and, during past years, some prospecting was done in the diabase near Mallard lake. An old pit in the south half of lot 10, concession VI reveals a narrow calcite-quartz vein containing a little cobalt bloom. On the south half of lot 11, concession VI a pit was sunk on a three-inch calcite-quartz vein containing some small masses of galena, a sample of which contained 4 oz. silver per ton.

Bayly Township

No work was being done in this township while the geological examination was being made. During past years, however, several pits were sunk in the search for silver. On claim J.S. 19, which is in the south part of the south half of lot 7, concession III, there are three pits in diabase showing some small gash veins. Some of the material on the dump of one pit carries a little galena, zinc blende, and garnet in calcite-quartz veinlets. The veinlets indicate no value where exposed.

On the northwest quarter of the north half of lot 5, concession III, there is a pit on an aplite dike 2 to 3 inches in width which runs N 17° W in a wide diabase dike. The aplite carries copper pyrites, but no cobalt bloom, often an accompaniment of aplite, was observed along the dike.

Mulligan and Pense Townships

In 1906, R. E. Hore examined an area south of Wendigo lake including parts of the townships of Ingram, Pense, Bayly, and Mulligan, where several small quartz veins carrying cobalt bloom had been found in Nipissing diabase. No native silver or argentite was seen, but Mr. Hore noted small quantities of sphalerite, galena and smaltite in some of the veins.[1] In 1918 many of these claims showing cobalt bloom were re-staked, but no further development work was done.

Brick Industry

All through the clay belt, the Pleistocene clay is remarkable for its even stratification. The bands are alternately of light and dark colour, the light layers containing more lime. Attempts have been made to use the clay for the manufacture of bricks at Liskeard and Haileybury. The clay in the upper 6 feet contains many limy nodules, apparently the result of percolating waters, and where these are not removed from the brick clay, white spots result which spoil the appearance of the bricks and later cause them to burst, owing to the slaking of the lime of the nodules. Even when the clay is obtained from a deep pit where no nodules are present, it is found that the bricks are of an inferior quality, owing to the large content of lime. To overcome the difficulty, sand was added, but owing to its scarcity in this district, the cost of production of bricks was too high for competition with outside firms. Lately the Haileybury Brick and Tile Company made the discovery that the finely ground diabase, so plentiful at Cobalt, could be used in place of sand. By experimentation, a suitable mixture of ground diabase and clay has been found and bricks much superior to those formerly produced are now being made. The increased cost of production has been more than overcome by the increase in number of good bricks obtained.[1]

---

[1] Ont. Bur. Min. Reports, Vol. XVI, Part 3, 1907, p. 135.

Limestone

Some of the limestone of the area is suitable for building, for the making of lime and for use in the manufacture of paper pulp.

Limestone (Lockport) cliffs at Dawson Point, Lake Timiskaming.

Farr Quarry.—Just south of the map area at Haileybury, in lot 2, concession III, Bucke township, is the Farr quarry, which has been shipping Trenton limestone to the Abitibi Pulp and Paper Company's plant at Iroquois Falls for a number of years. The limestone is used in a sulphide plant for the manufacture of paper pulp. The limestone has been shipped continuously from 1915 to 1921, inclusive, the total value of the output being in the neighbourhood of $22,082.

Lime.[2] All the lime that has been produced in the area has been made from the Lockport formation. At present a kiln is situated west of Liskeard and owned by Mr. W. Taylor [and shown on the accompanying map] is the only producer of lime in commercial quantities. Analyses of the limestones gave the following results:

ANALYSES OF LIMESTONE FROM HAILEYBURY AND LISKEARD.

	Farr's Quarry. Per Cent.	Taylor's Quarry. Per Cent.
Insoluble residue	5.06	2.96
Aluminum and iron oxide	0.87	1.87
Calcium oxide	44.81	31.98
Magnesium oxide	5.90	10.86
Carbon dioxide	42.40	51.85
Total	99.40	99.52

G. S. Hume, collector and analyst.

---

[1] Sum. Rep. Geol. Surv. Can., 1916, p. 191, by G. S. Hume.

[2] Ibid, pp. 191, 192.

W. G. Miller[1] found a sample of limestone from the Farr quarry on analysis to yield as follows:—insoluble residue 1.60; ferric oxide and alumina .66; lime 29.50; magnesia 21.59; carbon dioxide 46.84; sulphur trioxide .70; total 100.89 per cent.

David Bass of Thornloe has a small outcrop of Silurian (Lockport) limestone on his farm in the south part of lot 1, concession II, Armstrong township, from which some lime is made at times for local use. Fragments 5 inches across are burned in a small kiln which has a capacity of 200 bushels in 96 hours.

Lime kiln on lot 1, concession II, Armstrong township.

Building Stone.—Rocks of both the Trenton and the Lockport formations have been used as building stone to some extent.

In Haileybury several buildings, chief among which is the cathedral, have been made of stone taken from Farr's quarry, west of the town. The stone, which is Trenton in age, is of a bluish grey colour on the fresh surface and of a pleasing appearance, but, owing to the great thickness of the individual beds, the stone is not readily obtained in blocks of the proper size and with smooth surfaces.

A good quarry for building stone has been opened on the east side of Mann or Burnt island, from which stone was taken to build the public library of New Liskeard. The stone is buff to cream-coloured and occurs in the quarry in uniform beds six to eight inches thick. Jointing, too, is well developed and fairly regular, so that waste in quarrying is not excessive. Owing to the ease with which the stone may be extracted and to the fact that it can be transported by boat to any of the towns around the lake, this quarry should become of considerable commercial importance in the near future.[2]

Limestone in various parts of the area has been used locally for building foundation purposes.

---

[1] Ont. Bur. Min. Report, Vol. XIX, Part 2, p. 107.
[2] Sum. Rep. Geol. Surv. Can., 1916, p. 192, by G. S. Hume.

Quartzite

Silica Granite Products Co.—This company owns the south half of lot 3, concession III, Henwood township, which is 3½ miles from a railway. Much of the lot is covered by a grey Animikie quartzite, which is common in many townships of the area. It could not be learned why a plant, consisting of a boiler, jaw crusher and trammels, had been installed at this point, when similar rock occurs nearer railway transportation.

Outcrop of Silurian (Lockport) limestone at Dawson Point, Lake Timiskaming.

Peat Bog

Maybrooke.—This bog is on the Temiskaming and Northern Ontario railway between mileages 121 and 123 in Kerns and Harley townships. The surveyed outline of the bog, as furnished by S. B. Clement, chief engineer for the railway, has been placed on the accompanying map. It contains approximately 1,281 acres, namely:—

Acres	*Depth of Peat, ft.*	*Volume in Cubic Yards.*
232	Less than 5; average 4.	1,498,000
671	5 to 10; average 7.	6,890.000
378	10 to 15; average 11.	6,705.000

The peat is composed principally of sphagnum, heavily mixed with carex, eriophorum and other plants.[1]

Sand and Gravel

The sand and gravel areas are outlined on the accompanying map. Wherever convenient, the gravel has been used for road dressing and construction purposes. Enormous quantities have also been used for railway ballast. A fine sand, containing some clay and suitable for moulding purposes, occurs on the farm of J. Haddoux, lot 3, concession I, Kerns township. One carload has been shipped to the Wabi Iron Works at Liskeard.

---

[1] The Mining Industry in that part of Northern Ontario served by the Temiskaming and Northern Ontario Railway, 1919, by A. A. Cole.

Water Supply

In the large plain extending from Liskeard to Englehart, the Paleozic limestone is overlain by 100 to 250 feet of clay, in portions of which surface well water is scarce, particularly since the forest has been largely cleared away. Numerous deep wells have been drilled in portions of the area from which abundance of water is obtained. In many wells the water rises to a point near the surface and is pumped, while in others the water has a constant flow. Some wells flow during the spring and autumn and are pumped during other seasons. Thornloe obtained an artesian well with a flow of 6 gallons per minute after drilling through 230 feet of clay, 8 feet of quicksand and 35 feet of grey limestone.[1] The water supply of the town of Liskeard comes from several deep wells. In most parts of the area where boring has been done a supply of water is usually obtained.

Hydro=Electric Power

In 1914, in the early stage of development of the Tough-Oakes gold mine to the north of this area, a 1200 horse power hydro-electric plant was built at the south end of Long lake at Charlton. The power is transmitted at 33,000 volts on a three-phase transmission line to Kirkland Lake, part of the line being shown on map, Number 31b. The Charlton plant also furnishes light, heat and power to the towns of Charlton and Englehart, and to some farms. Following upon further development, the Northern Ontario Light and Power Company bought the Charlton plant and also extended its transmission line from the sub-station at Cobalt to Kirkland Lake, a distance of 65 miles. Thirty-nine miles of this transmission line is also shown on the accompanying map-sheet.[2]

A small power was developed on the Wabi river in Dymond township by the town of Liskeard; however, this plant was taken over by the Northern Ontario Light and Power Company and closed down.

A power has been partially developed on the west end of Wendigo lake in Marter township by the Canadian Associated Goldfields interests. The plan was to dam the outlet of Wendigo lake and allow the water to pass through a flume, one mile in length, which would empty into the Blanche river below a series of rapids and falls, thus attaining a head of 135 feet. Some rock excavation was done in 1920, and in 1921.

Approximately 2,000 horsepower could be developed on the north branch of the Blanche river in lot 2, concession IV, Marter township, where a total operating head of 138 feet is available. The discharge of the river on May 6th, 1915, was 552 cubic feet per second.

---

[1] Mining Industry in that Part of Northern Ontario Served by the Temiskaming and Northern Ontario Railway, by A. A. Cole, 1914, p. 65. Logs of wells drilled at other stations by the T. & N. O. Railway are given in Mr. Cole's report for the years 1915 and 1916.

[2] On October 4th, 1922, a large part of the Blanche River area was visited by a disastrous fire, resulting in the loss of some 43 lives. Many farmers were burning slash, brush and stumps as is customary at this season. Deciduous trees had shed their leaves and these were dry as tinder. Following a protracted dry period a high wind sprang up, fanning fires which spread with great rapidity. Houses and farm buildings, several villages, the town of North Cobalt and the greater part of the town of Haileybury were destroyed. Haileybury was burned in two hours, while Liskeard was saved by a sudden change in the high wind. In addition, twelve miles of electric transmission line, which supplied the Kirkland Lake gold area with power, was destroyed, causing the loss before repairs were completed of a full month's output. The localities hardest hit were Casey, Evantuel and intervening townships. Settlements along the Elk Lake branch of the T. & N. O. railway were also destroyed. In consequence many of the buildings shown on the accompanying map (No. 31b) no longer exist.

INDEX

Vol. XXXI, Part 3

PAGE
Agglomerate 1, 5
Agricultural land 1, 3, 9
Algoman. *See* Laurentian.
Amygdules 4
Analyses
  Andesite: dactite 5
  Limestone 17, 18
Andesite 4-6, 10
Animikie series 4-7, 19
Aplite dikes 13, 14
Armstrong tp. 9, 18
Auld tp.
  Rocks 4-7
  Silver 1, 2, 8, 13-15
Basalt 4, 10
Bass, David 18
Batholiths 6, 12
Bayly tp.
  Rocks 4-6
  Silver 16
Beauchamp tp.
  Agricultural land 3
  Morainic ridge 9
  Rocks 3-5
Biotite granite 6
Biotite schist 5
Blanche river
  Clay 3
  Gold 12
  Profile of part 21
  Rocks 2, 8
  Waterpower 20
Black River formation 2, 8
Borgford, George 11
Borgford gold claim 10, 11
Bradley-Donaldson silver mine 15
Brethour tp. 3, 5, 9
Brick clay 9, 16
Bryce tp.
  Gold 1, 5, 10-12
  Morainic ridges 9
  Rocks 4-7, 10
Bucke tp. 17
Building stone 8, 18
Burnt (Mann) island 18
Burrows, A. G. 2
Bushnell silver mine. *See* Casey-Cobalt silver mine.
Calcite veins 13
Canadian Associated Goldfields 20
Cane tp.
  Clay 9
  Rocks 3-8
  Sand plain 9
  Silver 1, 2, 8, 13
Cane Silver Mines 13
Casey mt. 15
Casey tp. *See* Casey-Cobalt.
Casey-Cobalt silver mine
  Notes 15
  Ore, origin 8
  Production 1
Cataract formation 3

PAGE
Chamberlain tp.
  Agricultural land 3
  Gold: rocks 5, 6, 12
Charlton.
  Agricultural land 3, 9
  Rocks 6, 12
  Waterpower 20
Chlorite schist 4
Clarke, A. R. 1
Clay 1-3, 9
Clement, S. B. 19
Cobalt, Ont. 17
Cobalt bloom 8, 14, 16
Cobalt series 10
Cole, A. A. 20
Conglomerate 6, 7, 10
Copper pyrites 16
Dacite 4, 10
Dack tp.
  Agricultural land 4
  Gold prospecting 1, 12
  Rocks 4, 5
Dawson pt. 8, 17
Diabase 5-8, 14
  See Nipissing diabase for bricks 17
Dolomite. *See* Lockport formation.
Dymond tp. 7, 20
Earlton 3, 6
Englehart 8, 9
Erythrite. *See* Cobalt bloom.
Farm land. *See* Agricultural land.
Farr limestone quarry 17, 18
Feldspar porphyry 6
Fire 20n
Galena 16
Geology 3-10
Gold 1, 10-12
Glacial deposits. *See* Pleistocene.
Glacial striæ 9
Granite 6, 10
Granophyre 8
Grant gold claim 12
Gravel, economic 19
Greenwood, W. 1
Haddoux, J. 19
Haileybury.
  Brick clay 16
  Limestone, analysis 17
  Rocks 2, 8
Haileybury Brick and Tile Co. 17
Harley tp. 9, 19
Heisey, K. B. 1
Henwood tp.
  Clay: sand 9
  Quartzite 3, 6, 19
Hilliard tp. 9
Hitchcock, W. R. 15
Hitchcock silver claim 14
Hore, R. E. 7, 16
Hornblende schist 4
Hudson tp. 3, 7, 8
Hume, G. S. 2, 8
Hydro-electric power 20

PAGE

- Ingram tp.
  - Clay ... 9, 16
  - Cobalt bloom ... 8, 16
- Iroquois Falls ... 8
- Jeffrey, W. H. ... 15
- Judge ... 9
- Kearney, D. ... 1
- Keewatin formation ... 2-6, 9, 10
- Kenabeek ... 8, 15
- Kenabeek Silver Mines ... 15
- Kerns tp.
  - Clay: peat ... 19
  - Rocks ... 3, 8
- Kettle holes ... 9
- Keweenawan formation ... 4, 7, 8
- Knight, C. W. ... 14
- Krugerdorf rapids ... 21
- Laurentian (Algoman) ... 4, 6, 10
- Lava ... 1, 4, 5
- Leslie, H. T. ... 1
- Lime ... 17
- Limestone ... 8, 17, 18
  - *See also* Trenton limestone.
- Limestone, economic ... 17
- Liskeard (New Liskeard).
  - Agricultural land ... 1, 9
  - Brick clay ... 16
  - Fault scarp ... 8
  - Limestone, analysis ... 17
  - Waterpower for ... 20
- Lockport formation ... 3, 8, 17, 18
- Long l. near Charlton ... 3, 20
- Lundy tp. ... 6, 7
- McNeill, W. K. ... 1
- McOuat, Walter ... 2
- McPherson farm ... 12
- Mallard lake ... 16
- Mann (Burnt) island ... 18
- Maps
  - Blanche R. area (geol.). With Rept.
  - Index ... 1
- Marquis tp. ... 6
- Marter tp.
  - Gold ... 1
  - Rocks ... 4
  - Sand areas ... 3, 9
  - Waterpower ... 20
- Mica schist ... 4, 5
- Miller, W. G. ... 2, 8
- Morainic deposits ... 9
- Mulligan tp.
  - Cobalt bloom ... 8, 16
  - Rocks ... 5-7
- New Liskeard. *See* Liskeard.
- Niagara formation ... 2
- Niccolite ... 13
- Nipissing diabase ... 2, 3, 6, 7, 10

PAGE

- Northern Ontario Light and Power Co. ... 20
- Ontario Solid Silver Mines, Ltd. ... 14
- Ordovician. *See* Trenton limestone.
- Pacaud tp. ... 6
- Paleozoic ... 3, 8
- Parker gold claim ... 12
- Parks, W. A. ... 2
- Peat ... 19
- Pense tp.
  - Cobalt bloom ... 8, 16
  - Rocks ... 5, 6
- Pillow structure ... 4
- Pleistocene ... 3, 9
- Pontiac series ... 5
- Porphyry ... 6
- Pre-Cambrian ... 3-8
- Quartzite ... 3, 6, 19
- Quartz porphyry ... 6
- Quesnell gold claim ... 12
- Recent deposits. *See* Pleistocene.
- Robillard tp. ... 3, 4, 6
- Rothwell, T. E. ... 1
- Sand ... 3, 9
  - Economic ... 19
- Savard tp. ... 3
- Scott gold claim ... 12
- Shepp silver claim ... 14
- Silica Granite Products Co. ... 19
- Silver. *See also* Casey-Cobalt.
  - Mining ... 13-16
  - Wendigo lake ... 1, 2
- Silurian ... 3, 8, 18
- Skead tp. ... 5
- Smaltite ... 13, 14
- Soil. *See* Agricultural land.
- Sphalerite ... 16
- Striæ. *See* Glacial striæ.
- Superficial deposits. *See* Pleistocene.
- Table of formations ... 3, 4
- Taylor, Wm. ... 17
- Temiskaming and Northern Ontario Ry. ... 19
- Thelma Mining Co. ... 10
- Timiskaming lake ... 2
- Topography ... 3
- Trenton limestone ... 3
- Triangle Silver Mines ... 14, 15
- Wabi river ... 20
- Waterpower; water supply ... 20
- Wedge, J. A. ... 1
- Wendigo lake
  - Rocks ... 6, 7
  - Silver ... 1, 2
  - Waterpower ... 20
- Williams, M. Y. ... 2, 8
- Zinc. *See* Sphalerite.

PROVINCE of ONTARIO
DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES — THOS. W. GIBSON, DEPUTY MINISTER

THIRTY-FIRST ANNUAL REPORT
OF THE
ONTARIO DEPARTMENT OF MINES
BEING
VOL. XXXI, PART IV, 1922

Fourth Report
OF
JOINT PEAT COMMITTEE

By B. F. Haanel, Secretary

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed by CLARKSON W. JAMES, Printer to the King's Most Excellent Majesty
1923

CONTENTS

Vol. XXXI, Part IV.

Page
Introduction 1
Preparations for 1921 Operations .. 2
Operations during 1921:
Improved Plant No. 4 2
Portable Belt Conveyor 2
Plant No. 2—Moore Plant 5
Erection of Plant on Bog 6
Novel Features of the Moore Machine 7
Drying Field Required for Season's Output 9
Harvesting 10
Difficulties Encountered and Improvements Made 10
Conclusions Reached at the End of 1920 10
Table I—Operation of No. 2 or Moore Plant 12
Table II—Summary Trouble Sheet, Plant No. 2 13
Costs 14
A. —Capacity of Machine 15
B. —Production Cost 16

Page
Costs—*continued.*
C. —Overhead 16
D. —Cost if operated by Self-Contained Steam Plant 17
E. —Cost if driven by Semi-Deisel Engine 17
Farmers' Plant 18
Macerating 18
Loss of Peat Fuel through Fire.. 19
Sale of Manufactured Fuel 20
Harvesting 21
Meteorological Observations with reference to Drying 22
Outline of Investigation for 1922. 24

APPENDIX

Development of Peat Machinery ... 25
Necessity for further Government Operation 26
Cost of Manufacturing Fuel with the Combination Plant 26
Costs 27
Market 28
Plant No. 3, Small Peat Plant 28

ILLUSTRATIONS

Fig. 1.—Belt Conveyor in place for operation 3
Fig. 2.—New Spreader attached to Belt Conveyor 4
Fig. 3.—Another view of Belt Conveyor system, Excavator in distance 5
Fig. 4.—One of the eleven Caterpillar elements 6
Fig. 5.—Peat Fuel laid on the field by the new machine 7
Fig. 6.—Belt Conveyor and Spreader 8
Fig. 7.—Plant No. 2 in operation 8
Fig. 8.—Near view of Spreader; also Cutting Device 9

DIAGRAM

General plan of operation for single unit, Anrep-Moore machine peat manufacturing plant 23

FOURTH REPORT OF JOINT PEAT COMMITTEE

By B. F. Haanel, Secretary.

Introduction

The Peat Committee shortly after appointment early in 1918, carefully examined all existing reports and records concerning the manufacture of peat into a domestic and industrial fuel, and concluded that the air-dried machine peat process was the only economic one known to exist which gave promise of ultimate success when employed under conditions obtaining in Canada. To adapt this process to Canadian conditions, the Committee found that new types of peat manufacturing machinery, capable of performing the several operations required in the course of manufacture, had to be developed. Consequently, the investigation inaugurated by them resolved itself into: first, the design and construction; second, development, and third, operation of machines capable of operating under severe and adverse conditions, with the employment of the minimum number of labourers and with the minimum charge for repairs and maintenance.

The Preliminary Reports issued by the Peat Committee from their appointment in 1918, up to and including the year 1920, dealt with the design, construction, development and operation of the two different types of peat machines —designated as plants Nos. 1 and 2—which, in the opinion of the Committee, offered the greatest promise of success. The investigation also included the design, construction and development of a small peat machine capable of being operated by one man and two boys, suitable for the manufacture of peat fuel on a small scale by individual farmers, or groups of farmers or small communities. This machine, during this period, also passed more or less successfully through the stages of design, construction and development.

As a result of the progress made up to the end of 1920, the Committee were in a position to make in their Preliminary Report for that year the statement: "Although it is not possible for the Peat Committee to state at this time that Peat Fuel can or cannot be manufactured in Canada on a commercial basis, the results of the investigation so far conducted enable them to arrive at the following conclusions:—

(1) That the Anrep plant (No. 1) as it stands is in no sense commercial.

(2) That the Moore plant (No. 2) under certain conditions can be employed commercially for the manufacture of Peat Fuel.

(3) That the Anrep excavating element is the superior of the two and the logical one to employ, while

(4) The Moore spreading system is far more efficient and is the logical spreading system to employ."

Based on these conclusions, recommendations were made for conducting the investigation through the season of 1921, and for concluding same during the season of 1922-3. These recommendations were as follows:—

(1) That a portable belt conveyor be constructed for operating in conjunction with the Anrep excavating element for the purpose of combining the best elements of the two types of machines.

(2) To develop and commercially try out a small Farmer's Peat machine.

(3) To operate the Moore plant throughout the entire working season on a strictly commercial basis with the least number of men and without the supervision of the expert staff, in order to obtain valuable information and data concerning overhead costs, actual costs of laying fuel on the field, harvesting same and transporting to stock pile and loading into cars for shipment; also to determine the loss in time through breakages, etc. Further, it was desirable that this machine be operated in order that sufficient peat fuel be manufactured to supply the market already created.

Preparations for 1921 Operations

This report is concerned chiefly with the recommendations just cited, and includes a somewhat detailed analysis of the results obtained with Plant No. 2, which was operated on a strictly commercial basis during the entire season in accordance with the above programme. This plant was not put into perfect condition inasmuch as this would have involved the redesigning and reconstructing of the caterpillar elements, an expense which the Peat Committee did not feel warranted in incurring, hence the results obtained are inferior to what would be expected were these known defects of the machine removed.

Operations during 1921

Improved Plant No. 4

On June 1st the first car load of the new conveyor parts arrived at Alfred station, and during the same month the remainder of the conveyor parts arrived at the bog. The assembling of the conveyor parts was immediately begun, and the installation of the entire plant was sufficiently far advanced on August 5th to enable the conveyor to be turned over under its own power, and on August 20th, excavated peat was delivered to the belt of the portable conveyor. The time from August 20th to August 26th, was spent in making adjustments in order to permit the belt conveyor, spreader and excavator to work in harmony, and on August 26th, a very fair demonstration of the operations of the entire plant was made in the presence of the Peat Committee and others.

Portable Belt Conveyor

The portable belt conveyor, which takes the peat from the excavator and delivers it continuously to the spreader, is of novel design, and may even be described as a daring venture on the part of those responsible for the conception of the idea. Nothing of its kind had ever before been constructed, and although stationary belt conveyors of longer spans are in successful use, the attempt to employ a portable belt conveyor of the dimensions of this conveyor has never been made, so a great deal of credit is due to the engineer of the Peat Committee and to those responsible for the carrying out of the design and construction for the remarkable success which was achieved almost on the very day the conveyor was completely assembled.

The conveyor is 850 feet long, and is composed of ten 85-foot latticed, boxed girder sections connected together forming a flexible bridge member which is carried on eleven caterpillar elements, all of which are operated from the main caterpillar near the excavating element. This bridge supports a rubber-covered belt conveyor, 850 feet between centres, thus making a total length of belt of

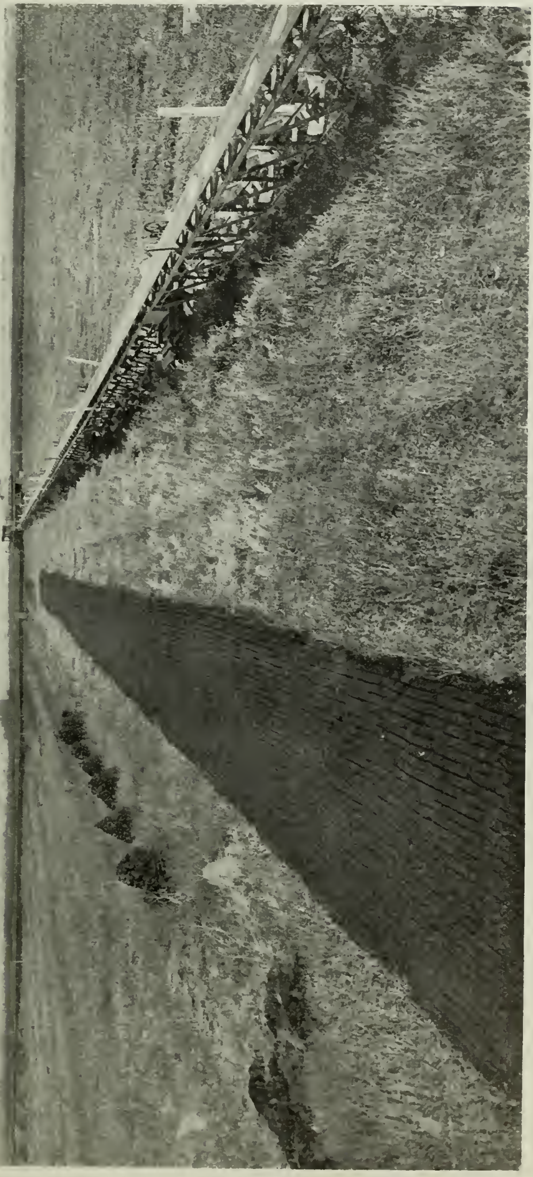


Fig. 1.—Belt Conveyor in place for operation.

1,700 feet. Fears were entertained that the conveyor would get seriously out of line and throw the belt off when attempts were made to move it under its own power over the field, but these fears proved entirely unfounded. In order to lay on the field ten tons an hour of standard peat fuel it is necessary to move the belt conveyor every 1¼ hours a distance of 13 feet 6 inches parallel to the line of travel of the excavating element, and this means a lateral movement of 108 feet in a working day of ten hours. The conveyor system in fact was put through a very severe test, a more severe test than it will ever be called upon to withstand in actual practice, and not only did it maintain its line, but in general, its behaviour far exceeded the expectations of its designers.

The spreader which was designed and constructed for use with this conveyor system was based upon the experience and results obtained with the spreader used on the Moore system. This spreader also had a very severe trial, and proved entirely satisfactory with the exception of a few minor mechanical details which will be changed.

The quality of the peat laid on the field by this improved plant is better than anything that has ever been obtained before at Alfred.

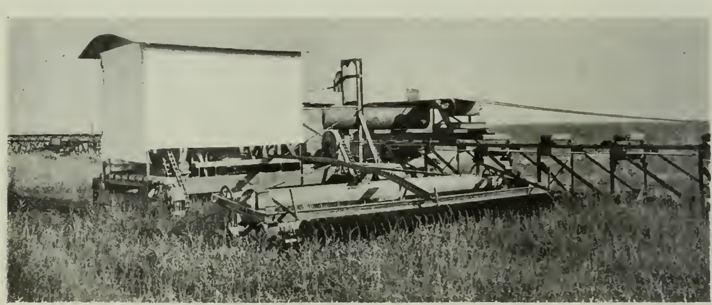


Fig. 2.—New Spreader attached to Belt Conveyor.

Fig. 1 shows the belt conveyor in place for operation. Fig. 2 shows the new spreader attached to the belt conveyor. Fig. 3 is another view of the belt conveyor system, and excavator in the far distance, and shows the unloading device for delivering the peat from the belt into the hopper of the spreader. Fig. 4 shows one of the caterpillar elements of which there are eleven, and also the take-up pulley at the extreme outboard end of the conveyor. Fig. 5 shows the peat fuel which was laid on the field with this new machine. This figure shows very clearly the effect of the improved longitudinal and cross cutters. It will be seen that the peat blocks are separated by a considerable space, and that this increases the drying surface over that obtained with former methods for cutting. This improved method of longitudinal and cross cutting, it is believed, will greatly improve the quality and resisting properties of the peat, as well as materially reducing the time required for drying down to 25 per cent. or 30 per cent. moisture.

Plant No. 2.=Moore Plant

This plant was constructed from original designs prepared by E. V. Moore, submitted to the Minister of Mines of the Federal Government before the formation of the Peat Committee, who decided that it should be constructed. In designing this plant Mr. Moore's objective was the reduction to as great an extent as possible of the number of labourers required to operate the plant, and his design shows a great many novel features which it was believed would realize this end. Neither this plant nor any plant of similar design, had previously been constructed, and it therefore devolved upon the Government and later the Peat Committee to construct and develop it into a successful machine. The advantages which were claimed for this design at the time it was presented were:—

(1) Lower cost of plant for a given output as compared with the Anrep system.

(2) Reduction in number of men required to operate, namely seven men compared with fifteen or more for the Anrep system.

(3) Four boys required to perform the operation of cubing, which required not less than twelve workers with the Anrep system.

(4) Number of men required for harvesting reduced by one-half.

(5) Fuel not loaded on railway cars automatically left in storage piles instead of remaining spread over the drying field.

(6) No delays incurred in moving tracks or bringing machine back to starting point, which delays are responsible for the loss of 25 to 30 per cent. of the total working time, when the Anrep system is employed.

(7) Extremely direct route of the peat from the working face to the drying field will permit using much less transmission machinery, and will provide more regular feed to the macerator and, therefore, increase its output.

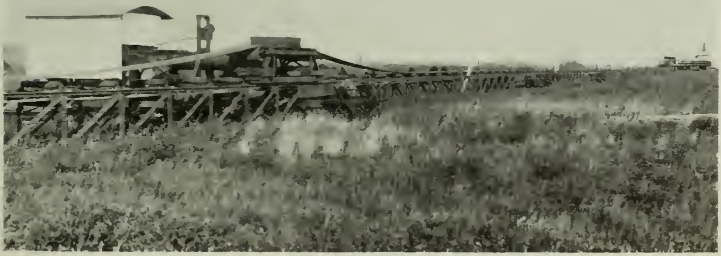


Fig. 3.—Another view of Belt Conveyor system, Excavator in distance.

The Government, and later the Peat Committee, after carefully considering these claims were convinced that the design possessed sufficient merit to warrant experimenting with a full-sized unit, and consequently the construction of this machine was authorized at the same time as the Anrep plant.

Erection of Plant on Bog

Although the contract to construct this plant was given sufficiently early in the season to insure its erection on the bog in time to give the plant a complete mechanical try-out during the summer of 1918, failure on the part of the contractors to meet their obligations made it impossible to begin erection until late in the Fall of 1918. Consequently it was impossible to investigate the mechanical behaviour of the plant until the spring and summer of 1919.

During this year, the Moore plant had a severe mechanical trial in the course of which a certain amount of peat was manufactured. This trial disclosed many weaknesses and faults in the design, which were remedied to as great an extent as possible during the following winter. In 1920, the Moore plant was operated for the manufacture of peat fuel throughout the entire working season. This season's investigation demonstrated to the satisfaction of the Peat Committee that the original claims enumerated above were not borne out in every particular. For example, it was found that the harvesting operation could not be performed with this machine without seriously reducing its capacity for making peat fuel. But a still more serious defect was disclosed, namely, the excessively long working face which this type of machine requires for laying down a season's production of peat fuel. In order to lay down one ton of peat fuel, the Moore machine must travel a linear distance of 56 feet. This not only means that the entire weight of the machine, excavating element, conveyor and spreader must be moved that distance, but also that in performing a season's work it will be necessary for the machine to travel approximately 60 miles. This is a very severe handicap for any machine, inasmuch as the wear and tear on the entire plant to perform this excessive travel would be abnormal. Moreover, the fact that a very long working face, approximately two miles in length, is required to lay down a season's production of fuel, will limit its employment to only a very few bogs. Even on bogs where such a machine could be employed, it would be impossible to operate economically more than one unit to advantage.

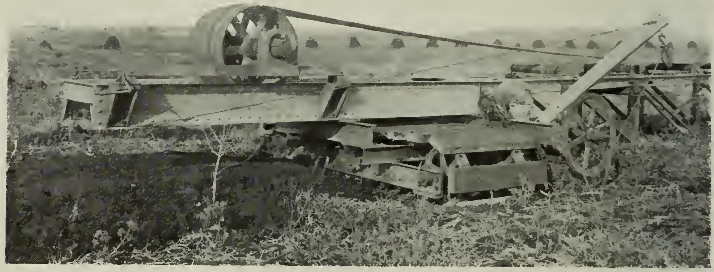


Fig. 4.—One of the eleven Caterpillar elements.

Another defect should be mentioned, namely, the difficulty of keeping the machine on the line of excavation. It has been observed that in order to keep the machine on the line of excavation and insuring that the excavator buckets remove a constant quantity of peat, a very skilful operator is required, and even then the quantity of peat excavated in a unit of time may not be constant.

Novel Features of the Moore Machine

A novel feature possessed by this machine is the method employed for transporting the excavated peat from the macerator to the spreader. This is accomplished by a belt conveyor which is flexibly attached to the middle of the main platform carrying the excavator and macerator. This belt conveyor is about 180 feet long, and is formed of a box girder about 30 inches square. The inside end of this girder is attached to the main platform, the balance of the weight being supported on a caterpillar element situated approximately 100 feet out, which is operated in unison with the caterpillars on the main machine through the medium of a power shaft connected to the caterpillar-driving mechanism on the main machine. The spreader is attached to this belt conveyor at any desired position, and is dragged along by the main machine. When one row is completed, the direction of the main peat machine is reversed, and the spreader is removed to the opposite side of the girder and shifted the required distance along the conveyor. After this row is completed, the main machine is again reversed, and the operation repeated until the requisite number of rows representing the season's output are laid on the field.

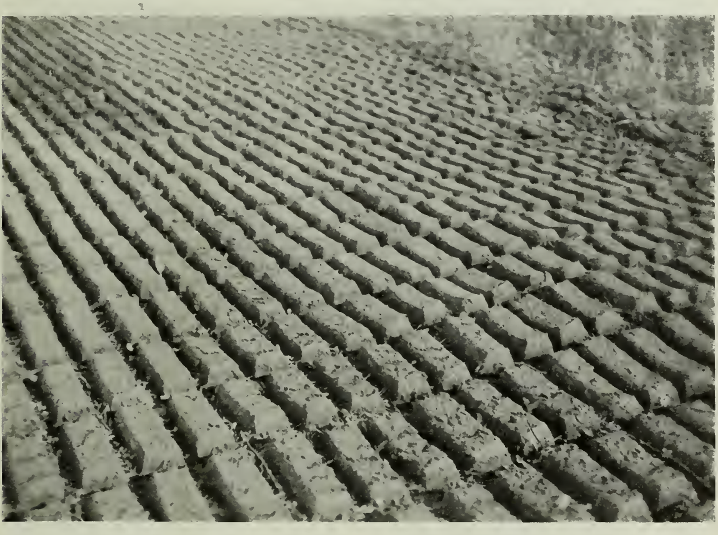


Fig. 5.—Peat Fuel laid on the field by the new machine.

Fig. 6 shows the belt conveyor with the spreader in position near the end farthest removed from the line of excavation, and the entire plant at the end of the working face ready to be reversed. This figure also shows clearly the peat laid on the ground. Fig. 7 is a general view of the No. 2, or Moore plant, in operation. Fig. 8 shows a close-up view of the spreader in the position indicated in Fig. 6 and clearly illustrates the operation of the cutting devices. It also shows the

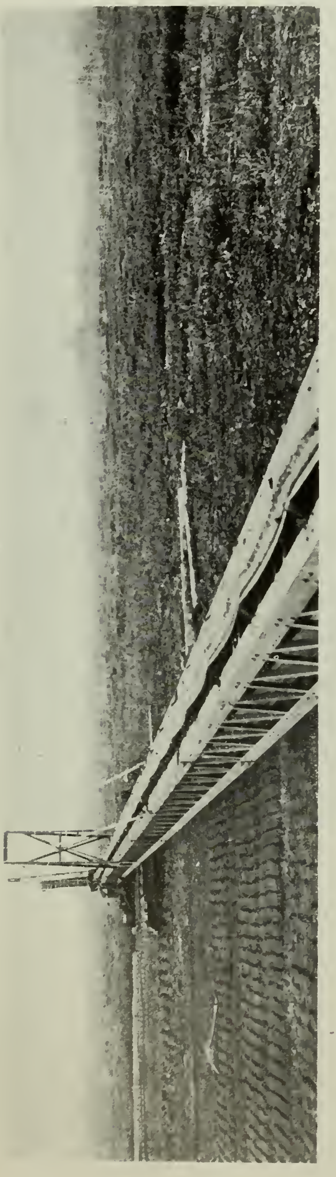


Fig. 6.—Belt Conveyor and Spreader.

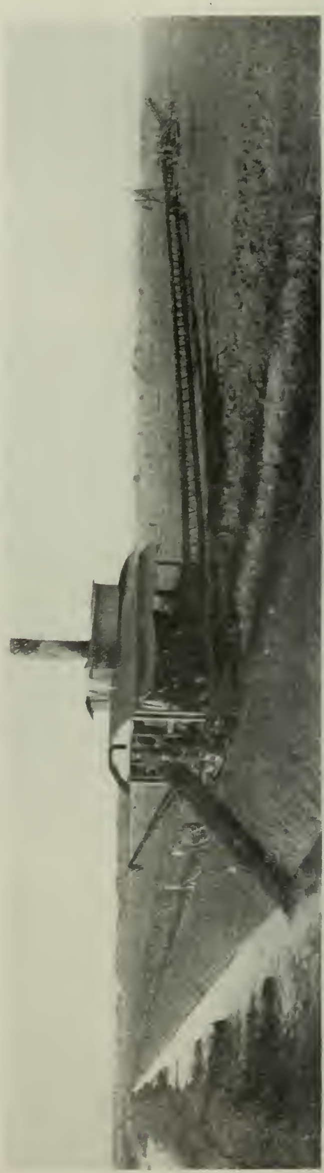


Fig. 7.—Plant No. 2 in operation.

position of the spreader when the maximum number of rows is laid. The elevator at the extreme end of the girder is used to convey the dried peat to stack or small train cars.

When the last row is completed the machine must either stop, or else the first row laid down must be sufficiently dry for harvesting, in order that the spreader may be placed in its original position and the operation of laying down peat again proceeded with as described. Fig. 7 shows also the device for unloading the peat from the conveyor belt to the hopper situated at the centre of the spreader. This hopper delivers into a box the full width of the spreader (12 feet) which is provided with a 14-inch standard spiral conveyor, one half of which is right hand and the other, left hand, both sections tapering from the full size at the centre to practically nothing at the ends. This spiral is rotated by power received from the transmission shaft which extends the full length of the bridge work, and insures that the peat fed in the hopper will be spread in a sheet of uniform thickness. The depth of the opening for the discharge of the peat on the field may be adjusted from 3 inches to 6 inches, and this opening extends over the full length of the box. By means of this regulation the thickness of the sheet of peat laid on the bog can be varied to suit conditions.

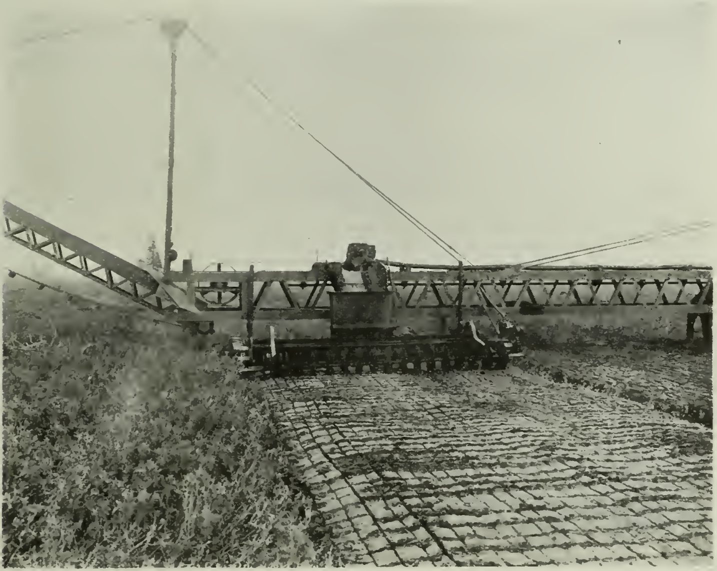


Fig. 8.—Near view of Spreader; also Cutting Device.

Drying Field Required for Season's Output

For an average production of 60 tons per day of ten hours, this machine must travel 3,360 lineal feet, and since a maximum of forty days is required for complete drying, it is necessary to provide a drying field which will permit the laying out of 120,000 feet of spreader section, that is 120,000 feet by twelve feet the width of the spreader times the depth of the peat spread. The belt conveyor is of sufficient length to provide for the laying down of 12 rows. The drying field for ten hours per day operation should, therefore, be 10,000 feet long in order to insure the complete drying of an average production of 60 tons of fuel per day. This is one of the chief drawbacks of the Moore plant. The working face provided for this machine at Alfred was 8,000 feet long, but this did not permit of the complete drying of the fuel and at the same time the production of the quantity of peat fuel for which the machine was designed.

Harvesting

When the machine was developed on paper, it was considered possible to employ the above conveyor for harvesting the dried peat at the same time that the peat slop was being laid on the field, but this operation it was found could not be efficiently performed without further experimentation. In short, all attempts to employ the conveyor for harvesting the dried peat fuel resulted in a decrease in the quantity of peat produced. Other methods of harvesting were consequently resorted to.

Difficulties Encountered and Improvements Made

The most serious difficulties encountered in connection with the operation of the Moore plant were occasioned by the caterpillar elements. When these were designed the engineer had very little data to guide him, since no machine capable of performing the operation required of a peat machine had ever before been designed for travelling over a spongy surface on caterpillar elements, consequently, serious defects were observed almost immediately in the design of the caterpillars and the mechanism driving them, and also in the method employed for steering the machine. Hence, most of the time and money which had been spent on alterations and improvements to this machine were expended on the caterpillar elements. As a matter of fact the caterpillar difficulties have not yet been eliminated. They could easily be improved or made perfect, but it was not considered necessary to rebuild the caterpillars for the purpose of completing the investigation of this machine, since it was decided, at the close of 1921, to cease operating the Moore plant.

Minor difficulties were also encountered in the excavating element and in other portions of the plant, but these were or could be eliminated without much trouble.

Conclusions Reached at the End of 1920

At the conclusion of the field operations at the beginning of the fall of 1920 a large amount of data was available for comparing the relative merits of the Moore and Anrep plants.

(1) It was clearly demonstrated that the Moore plant showed a marked economy in labour over the Anrep plant, but that in spite of this economy the Moore plant could not compete with the Anrep plant, provided the latter were equipped with an improved delivery and spreading system.

(2) It also appeared from the observations made during the operation of the Moore plant that the maximum length of the bridge work which can be supported by a single caterpillar had been practically reached, and that any extension of this bridge work would make the machine altogether too cumbersome to handle. Twelve rows of peat, therefore, appears to be the maximum number of rows which can be spread with a machine of the Moore type. As stated before,

a linear travel of 56 feet is required in order to lay down one ton of standard peat fuel, and a working face 10,000 feet long for a ten-hour shift, and 20,000 feet long for two ten-hour shifts. If it were possible to lengthen the belt conveyor bridge work to accommodate double the number of rows of peat laid, that is to say, the laying of 24 rows instead of 12, the length of the working face would be cut in two. This would remove certain of the difficulties under which the plant labours, but as stated it does not appear that the length of the belt conveyor can be sufficiently increased without making the entire plant too cumbersome and unwieldy.

(3) The advantage which it was also expected the Moore plant would have over the Anrep plant in harvesting did not materialize. This was due to two causes; (a) when harvesting operations were being carried on as originally intended, a stoppage anywhere along the line from the excavator to dumping into storage meant a stoppage of the entire equipment; (b) variations in the weather could not be provided for, that is, an exceptionally dry spell would permit the drying of the fuel to proceed too far before it could be harvested, and if the weather were abnormally wet, there was the further danger of the whole plant being stopped or held up waiting for the fuel on the ground to dry. On account of these two difficulties, it was decided that it would be more efficient to harvest the production of the Moore plant with the harvesting equipment employed with the Anrep plant—even though this equipment was not designed for operation in connection with the former—than to attempt to harvest with the machine itself as was originally intended.

(4) The quality of the fuel manufactured during the early part of the season compared unfavourably with that produced by the Anrep plant. This was in part due to the inferior quality of peat in that portion of the bog where the Moore plant operated, but it was also partially due to the fact that the long working face, over which the machine takes only one complete cut before a complete row is laid down, is likely to freeze to a considerable depth in a cold winter, and that the first rows which are made from the peat excavated from a frozen face would produce peat of an inferior quality. In the case of the Anrep plant the excavation is made over a very short working face, consequently, it is possible to dig away the frozen face before the operation of making peat is begun. A certain quantity of peat manufactured with the Moore plant during the season of 1920 was of inferior quality due to this cause.

(5) In order to carry out in the most economical manner the various operations in the manufacture of peat fuel according to the air-dried machine peat process, it is necessary that the plant and machinery employed be as simple as possible, since it is not feasible to have skilled workmen on hand to operate a plant which may be situated at some inaccessible point, and which, moreover, can operate for only a part of the year Any peat plant, therefore, which required for its operation skilled labour suffers a severe handicap. The Moore plant to a certain extent is under this handicap, since to operate it to the best advantage more skilful and more careful operation is required than with the Anrep plant. Moreover, the uniformity and quality of the fuel laid down by the former plant depends to a large degree on the care exercised by the operator. This applies to a certain extent also to the Anrep plant, but its operator has a much better control over his machine, and does not therefore require to exercise the same degree of skill.

On account of the above defects which were observed in the operation of the Moore plant and those which were noticed in the spreading system employed with the Anrep plant, the Peat Committee decided to recommend that the best features of both plants be incorporated in a combination plant. The following table gives the principal data obtained during the operation of the Moore plant in 1919, 1920 and 1921.

TABLE I.—OPERATION OF NO. 2 OR MOORE PLANT.

	1919	1920	1921
Total length of working season exclusive of Sundays		105 days.	107 days
Total days actual operation		(*a*) 41 days.	62.3 days
Unavoidable lost time		18.4 days	12.4 days
Percentage of season		17.5	16.6
Avoidable lost time		45.6 days	32.3 days
Percentage of season lost through delays which might have been eliminated		43.4	30.1
Distance travelled, about	45,000 feet	149,250 feet	242‘250 feet
Fuel laid down	(*b*) 500-600 tons	(*c*) 2,665 tons	(*d*) 3,889.5 tons
Fuel laid down per hour, average		3.4 tons	5.2 tons
Total labor cost to operate plant	$1,023 82	(*e*) $4,603.33	$3.380 27
Total labor cost for repairs		$1,138.50	700 77
Labor cost to lay out per ton		(*f*) $1.75	0.869
Cost of cubing per ton		(*g*)	0.20
Total labor cost ready to harvest.			1.07
Total labor cost if troubles eliminated			0.807
Maximum day production		53.6	70 tons

(*a*) Does not include 180 hours night work which is included to arrive at average production per hour in 1920.

(*b*) This distance travelled should have produced 800 tons, but no fuel was made during the first three or four cuts when working face was being opened up.

(*c*) It is estimated that 2,985 tons of fuel were made by No. 2 in 1920 on a basis of 50 lineal feet of row laid out per ton, and harvesting records would seem to confirm this figure, but 1921 records show it requires 56 lineal feet of row to produce one ton of 30 per cent. moisture fuel, and this figure has been used so as to make a fair comparison with 1921. The apparent greater production in 1920 is accounted for by the fact that the fuel harvested was not dried down to 30 per cent. moisture content.
About 1,600 tons of fuel made by No. 2 in 1920 sold for $4.00 per ton.
About 200 tons of fuel made by No. 2 in 1920, was used for fuel.
About 865 tons of fuel made by No. 2 in 1920 was not dry enough to harvest.

(*d*) Estimates of fuel made in 1921 on basis of 56 lineal feet of movement of spreader check very closely with actual weights.

Total fuel weighed into storage	3,194.5 tons
Total fuel used for fuel	221.0 tons
Total fuel wasted on field in harvesting	116.0 tons
Total fuel left on field not dry	358.0 tons
	3,889.5 tons
Known loss in production through thin spreading, about	450.0 tons
Total	4,339.5 tons
Theoretical production for 242,250 feet at 56 feet per ton	4,326.0 tons

(*e*) This figure includes $735.00 cost of night shift, and $700.00 paid to two additional men over regular shifts who were necessary to look after suction hose through which water was drawn to the boiler. For a fair comparison with 1921 this latter figure should be subtracted from the total, making cost per ton:

(*f*) $1.47

(*g*) Cost of turning and cubing in 1920 for the first part of the season was done by day labor. A great deal of work was done on old frozen peat in an attempt to save it, and the total cost for turning and cubing in 1920 is abnormally high, so that any figure given would be misleading. In the latter part of the season cubing was done by contract for 20 cents per ton.

During 1919, No. 2 plant was given a mechanical try-out, and only a small quantity of fuel was manufactured in the course of experimentation. In 1920 an effort was made to operate the plant during a full working season. The total length of the working season, exclusive of Sundays, was 105 days, and the total days during which the machine was actually operated was 41. It will be noted that the total days of actual operation during 1921 were greatly increased, and that the unavoidable lost time was reduced from 18.4 days in 1920 to 12.4 days in 1921, which corresponds to 17.5 and 11.6 per cent. respectively of the entire working season. The avoidable lost time during 1921 was notably decreased from that of 1920, namely, from 43.4 to 30.1 per cent. A very large increase will be noted in the lineal distance travelled by the plant in 1921 as compared with that travelled in 1920, and the average fuel laid down per hour in 1921 is notably greater than that laid down in 1920, namely, 5.2 tons, which is about 8-10ths of a ton less than the maximum which was expected.

It would appear, therefore, from the results of these three seasons that this plant could be brought to a high degree of efficiency, and that most of the mechanical troubles experienced could be entirely eliminated, which would make it possible to lay on the field the requisite quantity of fuel during an entire working season, provided a 10,000, foot working space were available.

It is necessary at this point to direct attention to the fact that no attempt was made to put the machine in perfect condition for operation during the season of 1921, since to do so would involve a large expenditure of money which the Committee could not recommend. This machine, therefore, began operations under a severe handicap which was in no sense decreased as the season advanced.

Regarding the total labour costs to operate the plant in 1921 as compared with 1920, it will be noted that for a greater production of fuel the labour cost is one-third less, and that the cost for repairs is also in the vicinity of one-third less than in 1920, but the decrease in labour cost is more noticeable in the costs calculated per ton of fuel laid down, namely, $0.869 in 1921 while in 1920 it was $1.75. This shows a reduction of approximately 50 per cent. If the troubles above-mentioned were eliminated, the labour costs for laying down a ton of fuel would be reduced to practically 81 cents. In 1921 the maximum daily production realized was 70 tons, while that of 1920 was 53.6 tons. The total quantity of fuel manufactured during 1921 was 3,889 net tons of 2,000 lbs., 450 tons were lost through defective spreading; the total production was consequently 4,439 tons. This checks very closely with the theoretical quantity which should have been produced for a lineal travel of 242,250 feet, namely, 4,326 tons. Table No. 2 gives a summary of the troubles experienced with the machine during the season of 1921, the time lost and the reasons therefor.

TABLE II.—SUMMARY TROUBLE SHEET, PLANT NO. 2, 1921

Cause	Unavoidable		To be expected		Due to known defects which could have been eliminated	
	Hours	Minutes	Hours	Minutes	Hours	Minutes
1. Weather	26	45				
2. Turning					11	55
3. Cross Ditches					3	15
4. Oiling					7	20
5. Move from field to field					20	40
6. Engine			4	0	4	35
7. Excavator element			10	0	14	45
8. Roots in Excavator			1	45		
9. Chains			8	0	52	17
10. Belt			1	10		
11. Spreader			12	0	39	35
12. Cross Cutter			4	5		
13. Ties			0	10		
14. Sprockets			8	20		
15. Clutches			4	0	8	5
16. Gears			1	0		
17. Late starting					0	50
18. No steam					10	30
19. No water					14	33
20. No fuel						40
21. Roots in Macerator			15	0	22	15
22. Iron in Macerator			10	0	31	45
23. Variable Speed			13	0	13	10
24. Loader					25	0
25. Stacker					0	45
26. Harvesting					3	40
27. Repairs			18	20	36	45
	26	45	97	50	322	20
Total	2.675 days		9.78	days	32.23 days	

Costs

While this investigation is being conducted for the purpose of developing machinery capable of performing all the operations required to convert the raw peat substance of a bog into a marketable fuel with the greatest degree of efficiency, such efforts would result in nothing but waste in time and money were the cost of the fuel so produced too great to permit competition with other classes of fuel now on the market.

The main objective has, therefore, been to develop machinery which can not only perform the various mechanical operations in the most efficient manner possible, but also produce a fuel at an economic cost. This has not proven to be a simple problem. The removal of one difficulty which barred the road to success often introduced another equally or more serious, and, as often happens in the development and refining of processes and their application commercially, the Peat Committee were confronted with the fact that the refining of mechanical appliances can be carried to a point where the saving resulting from the higher efficiency of labour-saving devices is more than offset by the increased cost. Consequently, the problem with which this investigation is chiefly concerned, resolved itself into the co-ordination of manual labour and mechanical labour-saving devices so that the human element and the mechanical element would be properly balanced.

In order to produce a low grade fuel like peat from a very low grade substance such as raw peat, which contains ninety per cent water and only ten per cent. combustible matter and ash by weight, with machinery capable of performing the various operations to a large degree automatically, the output of finished fuel per unit of time must be as large as possible. This implies a large and powerful manufacturing unit which in itself, introduces a serious difficulty, viz.: overhead costs.

Plant No. 2 was replete with labour-saving devices which partially defeated the very object of their introduction, and its elimination as a machine for manufacturing peat fuel on a commercial generally was partly due to these defects. A detailed estimate of the total cost of one ton of standard peat fuel as manufactured by this machine as it stands would consequently be of little or no value. In the light of the experience gained during two complete seasons' operations, a new machine of the Moore type could be built at a much lower cost than was possible with the original machine, and, moreover, the new machine would have incorporated into its design improvements which would correct many of the defects of the former, and would as a result be far more efficient, and under special conditions, even prove commercial.

With the results and records of operation now at the disposal of the Committee, it is possible to roughly estimate the cost of producing standard peat fuel with plant No. 2—re-designed and rebuilt. However, it must be understood that these costs are subject to revision in the final report when detailed estimates of the costs of a complete plant will be obtained.

The estimated cost of making fuel with the Peat Committee Plant No. 2 is based on the conditions:—

1—Plant rebuilt in light of all knowledge gained.
2—Plant is electric-motor driven.
3—10,000 feet working face available.
4—Minimum wages 35 cents per hour.
5—100 days minimum working season.
6—Ten-hour shift.

and that the capacity of the machine when re-designed and re-built will reach an average of 60 tons of standard peat fuel per day for 100 days. There is no reason to doubt that this and even a greater production would under these circumstances be realized. For convenience the details of the estimates are placed under the following headings:

A.—Capacity of machine.
B.—Production cost.
C.—Overhead.
D.—Costs if plant is driven by self-contained steam plant.
E.—Costs if plant is driven by Semi-Deisel engine.

The subject matter under these heads is sufficiently clear to require no further explanation.

A.—Capacity of Machine

Plant No. 2 moved 242,250 ft. in 1921 in 62.3 days elapsed time, of which four days were spent in shifting to new position.

Therefore, plant No. 2 moved 242,250 feet in 1921 in 58.3 days actual travel or 415.5 feet per hour. But observed speed of travel of machine was over 8 feet per minute, or, 480 feet per hour.

Therefore Plant No. 2 lost 7.75 days during 1921 operation not recorded in trouble sheet. Of this the greatest part was due to holding back when using its own harvester, and from travel records it is estimated this amounted to between 4 and 5 days, and the balance say 3.75 days was lost by short delays which were unrecorded.

There is no reason why an improved No. 2 Plant should not sustain a rate of travel of 8 feet per minute when in motion, equal to 480 feet per hour equivalent to production of 8.5 tons of fuel per hour.

Known unavoidable delays = 11.6 per cent.
Unrecorded delays = 3.6 per cent.
Delays due to shifting machine to new position on the field (on 10,000 ft.-face) = 1.8 per cent.

Total delays = 17 per cent.
Therefore capacity of plant should be 83 per cent. of 8.6 tons = 7.0 tons per hour
or per 100 days = 7,000 tons
Deduct for fuel 400 tons
left on ground 210 tons
waste at loading 5 per cent. 350 tons

Say 1,000 tons

Net amount available on cars = 6,000 tons

B.—Production Cost

This covers items which vary as number of tons manufactured.

Cost of raw materials on royalty basis per ton	0.05
Operation:	
Runner per day	$5 00
Man in excavator	3 50
Spreader	3 50
Spare man	5 00
Electrician and Mechanic	7 50
Fireman	4 00
Water boy and messenger	1 50
Total per day	30 00
Allowing 25 days to open up and close down for winter—	
125 days at $30.00 per day—Total labor cost	$3,750 00
or, per ton	0 625
Supplies, oil, etc.	0 015
Turning by contract	0 15
Harvesting to storage or Railway Cars	0 60
Total Production Cost	1 44

C.—Overhead

Estimated capital Investment:—		
No. 2 machine complete with motor drive	$10,000 00	
Harvester for same	1,200 00	
16.-lb. track 12,000 ft.	5,000 00	
12.-lb. track 2,000 ft.	600 00	
Harvester cars (12)	1,500 00	
Locomotive	1,500 00	
Storage and Loading Equipment	3,000 00	
Railway Siding	1,500 00	
Office, machine shop, power house and transmission	15,000 00	
Total Capital Layout	39,300 00	
Add for under-estimate and emergencies 10 per cent.	3,930 00	
Total say	$45,000 00	
Total Production Cost		1 44
For Capital Charge:—		
Write off for all purposes 20 per cent. of $45,000 00	$ 9,000 00	
or per ton for 10-hr. shift		1 50

for 16-hr. shift	95c.	
for 20-hr. shift	75c.	
For Executive overhead charge:—		
Manager for year	$2,400 00	
Clerk 8 mos. at $75 00	600 00	
Office Expenses	600 00	
Total	$3,600 00	
Or per ton on 10-hr. shift		0 60
16-hr. shift	37½c.	
20-hr. shift	30c.	
Add to re-handle from storage to cars		0 35
Total cost for 10-hr. shift		$3 89
16-hr. shift		3 11
20 hr. shift		2 84

D.—Cost if operated by Self=Contained Steam Plant

Raw material		0 05
Production Cost:—		
Fireman	$4 00	
Engineer	7 50	
Runner	4 00	
Man in Excavator	3 50	
Man to get Fuel	3 50	
Man on Spreader	3 50	
Spare man	5 00	
Mechanic Helper	3 50	
Water boy	1 50	
Total	$36 00	
Or for 125 days=$4,500 00; per ton		0 75
Add Supplies		0 015
Turning		0 15
For mechanic if manager and mechanic not same man		0 10
Harvesting		0 60
Total Production Cost		$1 665
Overhead:—		
No. 2 machine complete with steam power	$15,000 00	
Harvester 1	1,200 00	
Track 16-lb.	5,000 00	
Track 12-lb.	600 00	
Cars	1,500 00	
Locomotive	1,500 00	
Storage and Loading Equipment	3,000 00	
Siding	1,500 00	
Office and machine shop	2,500 00	
Total	$31,800 00	
Plus 10 per cent.	3,180 00	
Say	$35,000 00	
Or for 10 hours—overhead charges per ton		1 17
Executive overhead charge		0 60
Re-handling charge		0 35
Total		$3 79

E.—Cost if driven by Semi=Deisel Engine

Raw material		0 05
Production Cost:—		
Engineer	$7 50	
Runner	4 00	
Man in Excavator	3 50	

Man on Spreader	3 50	
Spare man	5 00	
Mechanic	6 00	
Mechanic helper	3 50	
Water boy	1 50	
Total	$34 50	
Or for 125 days—$4,312 50; per ton for 6,400 tons		0 68
Supplies		0 025
Turning		0 15
Harvesting		0 60
Total Production		$1 505
Overhead:—		
Total capital investment not greater than for steam, Or annual charge of $3,600 00 for 6,400 tons; per ton		$1 10
Total executive charge same as for steam, Or annual charge of $3,600 00 for 6,400 tons; per ton		0 56
Re-handling charge		0 35
Oil fuel 1 gal. per H.P. at 11 cents per ton		0 11
Total		$3 625
Summary:—Separate steam-driven power plant		3 99
Self-contained steam-driven power plant		3 79
Self-contained crude oil engine		3 625

Farmers' Plant

Plant No. 3 is in design a miniature Moore-Anrep combination plant. The method of supporting the excavating and macerating element is based on the principle employed with the Anrep system, while the delivery and spreader system employs the principles so successfully demonstrated in the Moore plant. But in order to combine the features of these two plants on a small and economical scale new problems arose which had to be solved. In the course of its development many discouragements were experienced, and it appeared at one time as if the entire design would have to be changed; but an alteration to the excavating-macerating element and a rebalancing of the other parts of the machine, together with the installation of a more powerful motor, eradicated many of the worst difficulties, and a few further changes put the machine into such condition that the Committee see no reason why it cannot be successfully operated during the coming season.

Like the larger machines, this small peat plant must also provide means to excavate, macerate and spread the pulped peat on the ground. In order to carry out these operations in the most simple and economical manner effort was made to design an element which would combine, in one, the operations of excavating and macerating.

As the machine now stands, it is expected that its average hourly capacity will be between 1 and 2 tons of standard peat fuel. This will amount to 10 to 20 tons during a working day of 10 hours. The machine is very simple to operate, and can be easily handled by 1 man and 2 boys.

Macerating

The degree to which maceration can be economically conducted has an exceedingly important bearing on the quality of the fuel produced. It is therefore essential that every effort be made, in attempting the manufacture of peat fuel according to the wet process, to obtain the highest degree of maceration consistent with economy. The results which have been obtained during the past three years have led the Peat Committee to conclude that the Anrep macerator as at present constructed is not entirely satisfactory for operation where a high rate of production is required. since it has been their experience that a large amount of the time which has been lost during a limited season of one hundred days during which it is possible to manufacture peat fuel, has been due to stoppages of the plant through choking or breaking of the macerator with roots and pieces of iron, which now and again find their way into it. To avoid loss of time through such stoppages, the Committee made arrangements with the Jeffrey Manufacturing Company of Montreal to experiment with a swing hammer shredder which they were led to believe might prove successful for macerating peat. This shredder arrived at the plant too late for experimentation, but a few minutes' demonstration run which it was possible to carry out showed that the maceration obtained with this machine was far superior to that possible with the Anrep macerator. This shredder will be tried out early in the spring of 1922, and in case it is found unsatisfactory, two Anrep macerators placed in parallel will be employed. Arrangements for installing them are now under way. This will make it possible to obtain the maximum production of peat fuel during an entire working day, and will avoid stoppages since it is not probable that both macerators will be choked up at the same time. Moreover, while one is being cleaned, the other can be overloaded for a short time thus insuring the delivery of a more or less continuous supply of peat to the belt conveyor.

Loss of Peat Fuel through Fire

On November 8th fire was discovered in the stock pile of fuel which contained a portion of this season's production, a quantity of fuel manufactured last season and several hundred tons of broken frozen peat and fines. The fines were stored in this pile preparatory for shipment as a fertilizer-filler and soil-conditioner. The portion of the stock pile where steam and smoke were seen to issue was immediately opened up, and efforts made to quench the incandescent fuel thus exposed. Towards the evening of this day it appeared to those in charge that the fire had been put out, or at least got under control, since smoke ceased to issue from any part of the pile. But a rising wind soon revived the fire which broke out in other parts of the pile, and though strenuous efforts were made to locate the seat of the fire, this proved impossible since it spread with great rapidity when it reached the good peat fuel where an abundant supply of air was available. The meagre and inadequate equipment available which could be used for fighting a fire proved of little avail, and efforts to cut the pile in two, in an attempt to separate the burning peat from the good peat fuel failed owing to a change in the direction of the wind, which blew the poisonous gases resulting from incomplete combustion upon the workers and necessitated their hasty withdrawal. Consequently it was possible to salvage only a very small quantity of the fuel.

Prior to November 8th the superintendent of operations and the engineer to the Peat Committee, who examined the stock pile on many occasions, had no reason whatever to suspect that the peat was on fire, and moreover, the great rapidity with which it developed appears to indicate that it was of very recent origin.

A thorough investigation failed to reveal the cause. It may have been due to carelessness on the part of a labourer, or to a spark from a locomotive which, lodging in the fines, was covered by freshly dumped peat and slowly ignited the fines at a considerable depth. But the theory that the fire was the result of spontaneous combustion can be given but little credence, since there is no record of a peat fire originating in this manner in European countries, where it is the practice to store great quantities of peat in this manner.

Hereafter the peat will be stored in separate piles. This will permit a fire to be attacked more efficiently—should one ever occur again—and at the same time insure the minimum loss, inasmuch as a fire in one pile would be confined to that pile.

However unfortunate such a loss may be, no blame, in light of the evidence obtained, can be attached to any member of the staff responsible for the conducting of the investigation at Alfred.

The stock pile before burning was over 22 feet high, from 30 feet to 40 feet in width at the top and about 100 feet in width at the bottom. These dimensions will give some idea of the difficulties encountered in the attempt which was made to cut the pile in two.

It is estimated that the loss by fire was:—

Quality.	Quantity	Estimated Value.
1921 Good peat fuel	1,780 tons	$8,500 00
1920 Poor disintegrated fuel	600 "	1,800 00
Screenings	100 "	300 00
Damage to trestle		400 00
Total		$11,000 00

Sale of Manufactured Fuel

The Peat Committee has met with considerable difficulty in disposing of the fuel manufactured to the best advantage. This has been occasioned partly by the nature of the work which the Peat Committee is conducting, namely, an investigation which is concerned more with the development of the machinery for manufacturing peat fuel than with the product itself. Consequently, the quality of the fuel placed on the market has not in certain instances been of the best. In order to dispose of the fuel made during a season in the most economical manner, it has been found impossible to avoid shipping a certain portion of the inferior fuel with the good fuel, and a small quantity of the former has therefore found its way into households, and has given rise to a certain amount of dissatisfaction. While it is necessary to call attention to this fact, it is gratifying to know that the complaints from inferior fuel have been exceedingly few, and that by far the greater portion of the fuel sold since the inauguration of the Peat Committee's investigation, so far as the Committee could ascertain, has given complete satisfaction.

The operation of two experimental machines with the consequent laying out of fuel on two sections of a bog widely separated, made it impracticable to instal harvesting and loading apparatus which would enable these operations to be carried out in the most economical manner. The installation of the proper facilities for efficiently harvesting and handling the fuel manufactured would have involved a comparatively large capital expenditure, which the Peat Committee did not feel warranted in incurring, on account of the temporary character of the work they are conducting. Harvesting operations will be discussed under a separate heading.

The policy of the Peat Committee is to dispose of the fuel manufactured to householders, in order to introduce this fuel for domestic purposes. A considerable portion, however, was sold for heating office buildings and to a certain extent the Government buildings of Ottawa, but care was taken not to permit the fuel, in wholesale lots, to get into private hands.

The selling of the fuel in Ottawa and Ottawa district was put in the hands of a selling agent, who undertook to dispose of the entire output. The agreement which the Peat Committee made with him called for the production of 4,000 tons, but this agreement was broken by both the sales agent and the Peat Committee, first by the former in not accepting the delivery of peat as required, and later in the season by the Committee owing to the fire which destroyed a large portion of this season's output.

The selling and distribution of peat fuel presents certain problems which must be worked out independently. They are, however, all practical problems which can be handled more satisfactorily by business men. Peat sales for 1921 were as follows:—

Raw peat sold in cars	1,160 tons	at $5 00		$5,800 00
Raw peat sold locally	125 “	at 5 00		625 00
Old peat sold in cars	85 “ 18 “	at 3 00 at 2 50		300 00
Screenings sold in cars	113 “	at 3 00		339 00
Peat on hand saved from fire and sold for future delivery, estimated	50 “	at 3 75		187 50
Approximate total sales	1,551 “			$7,251 50
Less contract in connection with sales in Ottawa and Hull, estimated			$460 00	
Joliette Steel Company			248 75	
Car Screenings to Fuel Testing Station			71 16	759 91
Net				$6,491 59

Harvesting

The harvesting of the finished peat fuel which comprises the operations of taking the fuel off the ground, loading on small tram cars, transporting these to loading trestle and unloading small cars on storage pile or into freight cars for shipment, has presented many problems, certain of which must be worked out independently. Prior to the war such operations have been largely performed by hand labour, but during and since the war labour conditions have changed very materially. As regards wages, and in order to carry out these operations in the most efficient and economical manner, manual labour must be replaced to the largest extent by mechanical devices. When the Peat Committee undertook this investigation, they were of the opinion that the harvesting of a season's production of fuel would not present any problems of unusual nature, and that the ordinary methods could be employed without increasing unduly the cost of the fuel. As the investigation proceeded, however, it has been discovered that harvesting constitutes one of the most important problems, second only to the manufacture of the fuel itself, and that if this operation is not conducted in the most economical manner possible, the economies realized from the development of peat fuel manufacturing machinery will be more than offset by the cost of the former.

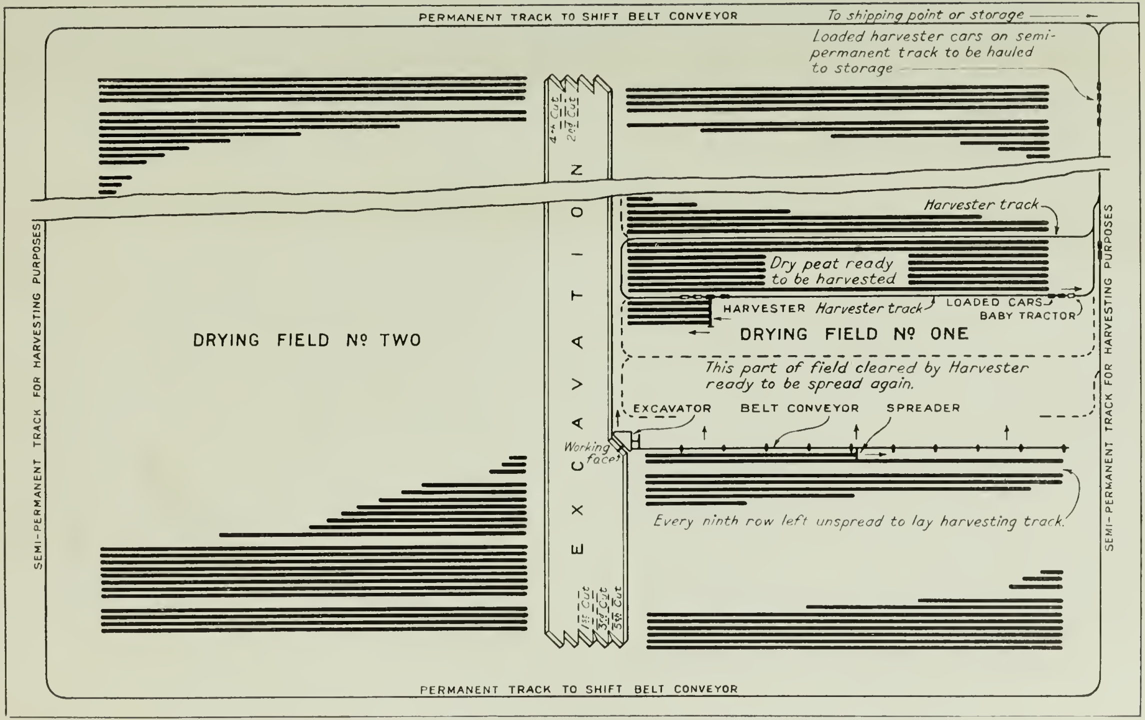
As time permitted, close attention was given to the problems presented in harvesting, and automatic devices were designed, constructed and tried out for certain operations heretofore performed by manual labour. While considerable progress has been made in this direction, the problem is by no means entirely solved, and economies in advance of those so far obtained may be expected. Harvesting a season's production of the No. 4 plant—the combined Moore-Anrep plants—can be performed at a less cost than was the case with plant No. 2, but with the latter plant, little attention was paid to this particular problem, when it was realized that harvesting could not be performed economically by the machine itself. If plant No. 2 had proved satisfactory for commercial operations generally, instead of for special isolated cases, the problem of harvesting a season's production of fuel laid down with that machine would have demanded closer consideration.

The Peat investigation was undertaken at a time when the costs of raw materials entering into the construction of peat machines and general equipment required for the peat manufacturing plant were inordinately high. At this time also labour wages reached the highest level. To-day, these conditions have materially changed; peat manufacturing machinery and other equipment required can be purchased for practically fifty per cent. of the war prices, and labour wages have also dropped materially. The figures of cost which have been prepared for this report are consequently based on higher labour wages than it is expected will obtain during the season of 1922-3.

Meteorological Observations with reference to Drying

Meteorological observations including precipitation, temperature, and barometric pressure, have been made during the season 1920 and 1921. A full record of these observations as well as a complete report on the drying of peat fuel as observed at Alfred will be included in the final report. It will suffice to say here that the observations covering the last two seasons have shown that the maximum period during which peat fuel can be manufactured—that is, laid on the ground and dried sufficiently for shipment—is one hundred working days.

It has been ascertained that peat manufacturing operations can begin as early as the 1st of May and be continued up to the 25th of August.


PERMANENT TRACK TO SHIFT BELT CONVEYOR
To shipping point or storage
Loaded harvester cars on semi-permanent track to be hauled to storage
SEMI-PERMANENT TRACK FOR HARVESTING PURPOSES
4th Cut
2nd Cut
EXCAVATION
1st Cut
3rd Cut
5th Cut
Working face
DRYING FIELD Nº TWO
Harvester track
Dry peat ready to be harvested
HARVESTER
Harvester track
LOADED CARS
BABY TRACTOR
DRYING FIELD Nº ONE
This part of field cleared by Harvester ready to be spread again.
EXCAVATOR
BELT CONVEYOR
SPREADER
Every ninth row left unspread to lay harvesting track.
SEMI-PERMANENT TRACK FOR HARVESTING PURPOSES
PERMANENT TRACK TO SHIFT BELT CONVEYOR

General plan of operation for single unit, Anrep-Moore machine peat manufacturing plant.

Outline of Investigation for 1922

In accordance with the programme submitted in the spring of 1921, the investigation for 1922 will be confined to the operation of the new combination plant and the small plant No. 3 on a commercial scale, the former through an entire working season, and the latter for a sufficient period to demonstrate its value for the work it was designed to perform. The Jeffrey swing hammer shredder which was shipped to the bog last fall too late for experimentation will be thoroughly tested out early this spring, and if the results are satisfactory, it will be employed during the working season for macerating the peat excavated by the combination plant. It is not expected that any new equipment will be purchased, nor will any construction be undertaken with the exception of that involved in the replacing of the loading and storage facilities, which were destroyed by fire. Additional machinery which may be required to carry to completion the investigation will if possible be rented instead of purchased. Arrangements have already been made to rent at a nominal cost an engine for operating the swing hammer shredder, in case it is satisfactory, or the two Anrep macerators in parallel. This engine if purchased would have cost the Committee considerably over $2,000, while on the rental basis it will involve an expenditure of approximately $400 to $500.

Just as soon as the snow is off the ground the new combination plant will be put into condition for beginning commercial operation about the 1st of May. Plant No. 2 will be dismantled, with the exception of the boiler and propelling engine, which it is proposed to employ for supplying the extra power required to operate the new plant.

The harvesting equipment has already been overhauled, so that this is in order for the coming season's work. In order to render the combination plant commercial in every respect an hourly average production of ten tons of saleable peat fuel must be maintained throughout a working season of 100 days. There is no reason to believe, however, that this production will not be realized. An hourly production of ten tons of saleable peat fuel for ten hours a day and for a working season of 100 days means laying on the field a greater quantity than 10,000 tons of finished peat fuel. To accomplish this a longer working face will be required than was necessary for the Anrep plant as it was originally operated, and to provide the additional working face it is planned to operate on both sides of the main excavation according to the plan on page 23. This shows two drying fields, Nos. 1 and 2 . It also shows the semi-permanent tracks which will be laid for harvesting purposes, and the permanent tracks at both ends of the field for shifting the belt conveyor from No. 1 drying field to No. 2.

At the conclusion of the working season in 1922 the preparation of the final report of the operations of the Peat Committee since the inauguration of the investigation in 1918 will be begun immediately.

(APPENDIX)

INTERIM REPORT OF JOINT PEAT COMMITTEE

The original objective which the Joint Peat Committee had in 1918, the year of its appointment, was the testing of peat machines under commercial conditions, in order to determine if a type suitable for manufacturing peat fuel on a commercial basis could be developed. By a process of elimination two types were selected, the well known Anrep peat machine, largely used (in the smaller sizes) in European countries, and the Moore machine. The latter, while not fully developed, appeared to possess so many obvious advantages that the Federal Government, before the appointment of the Peat Committee, decided that it should be given a trial.

On account of the precedence given to war contracts, the two machines were not delivered at the Alfred bog, Ontario, until the spring of 1919, and their erection was only completed in time to enable a short mechanical try-out to be conducted before cold weather set in. It was not, therefore, until the spring and summer of 1920 that manufacturing operations were actually begun.

Up to this time the Committee was under the impression that its work would be completed at the conclusion of 1920 and that sufficient data would be available to enable an opinion to be expressed concerning the commercial possibilities of the two machines. The results of that season's operations, however, disclosed inherent weaknesses in both plants, and the Committee was unable to approve either type for commercial work. Recognizing the great value of a healthy peat development to the Dominion at large, the Committee recommended that a new combination be effected embodying the best features of the two types which had been tried out. This recommendation was approved by the two Governments, Provincial and Federal, and funds were allotted for carrying out the construction and operation of the new combination. The construction was completed late in 1921 and operations were concluded in 1922.

Development of Peat Machinery

The success of any such machine depends largely upon the elimination of manual labour to the greatest extent possible and on the production of a manufacturing unit of large capacity at the lowest possible cost commensurate with good service.

Attempts to meet these two conditions led to the trial of many mechanical devices which heretofore have not been used in this connection. The most noteworthy features involved were the adoption of caterpillar aprons and the substitution of a portable belt conveyor, an automatic spreading machinery for the track system and field presses formerly employed. The development of these and other mechanical features proved difficult and occasioned the expenditure of much time. While the machine has not actually been constructed to the design which the Committee esteems would be reasonably free from defects, the problems involved have, in their opinion, been thoroughly investigated, and drawings for a complete standard equipment with power plant, pulverizing unit, conveyor and spreading system are now under way.

Necessity for Further Government Operation

While the Committee has completed research work requisite to the development of a successful peat manufacturing plant, and is able to place at the disposal of those interested, construction data and operating statistics, it is of opinion that the esablishment of a peat industry is of such importance to Canada and especially the Province of Ontario, that the Governments should undertake the construction and operation of a perfected plant until its possibilities are fully demonstrated.

Cost of Manufacturing Fuel with the Combination Plant

The Committee after careful consideration arbitrarily fixed the price f.o.b. cars peat plant siding, at which peat fuel could in its opinion be sold for consumption, within a 100-mile radius and still compete with anthracite coal. This price was $5.00 per ton of standard peat fuel, containing thirty per cent. moisture, and comprises the following items:—1, production cost; 2, overhead charges; 3, manufacturer's profit.

The production cost depends mainly upon the cost of the raw material, the prevailing price of labour, the number of employees, seasonal variations, and the quantity of saleable fuel produced per unit per working season.

Overhead charges include interest on capital invested, depreciation and administration.

Manufacturer's profit is estimated as it would be arrived at by the investor.

The figures employed in this report are considered fair by the Committee. but those who desire to engage in such an enterprise would naturally estimate their own overhead charges and profit.

In order to keep items 1 and 2 sufficiently low to enable fair manufacturer's profit to be realized and still bring the selling price of peat f.o.b. cars within the limit of $5.00, it was estimated that the minimum capacity of a unit must be 10,000 short tons of saleable, standard peat fuel for a working season of one hundred days. This type of machine should be capable of producing a sufficiently high hourly average of peat fuel throughout an entire season, irrespective of seasonal variations and delays due to breakdowns or other causes, to enable the 10,000 ton figure to be realized. This we believe could be accomplished by constructing the complete unit sufficiently large to produce a maximum capacity considerably in excess of the minimum required.

The improved plant, exclusive of harvesting equipment, consists of four components. 1.–Excavating, 2.–Macerating, 3.–Distributing and spreading, 4.–Power.

The excavating element proved of sufficient capacity to meet all requirements, and the distributing and spreading system was sufficient to deliver and spread the maximum quantity of peat excavated. The macerating element, however, failed to deliver the required quantity with the power available. This was due to the adoption of a new type of macerator, a "Swing Hammer Pulverizer," which it was considerered would prove far more reliable, cheaper and more efficient than the Anrep macerator heretofore employed. This machine had not before been employed for macerating peat and, therefore, its capacity and the power required to operate it for such purpose were not known. A portion of the operating season had to be devoted to experimentation with and calibration of this unit.

On account of the lateness of the season, and lack of funds, the Committee could not possibly consider the purchase of a power plant sufficient to operate the combined plant to full capacity. The power plant used was improvised, comprising two boilers already on the bog, the wasteful steam engines which formed part of the two plants previously experimented with, and a high speed engine which was rented for a season. The two boilers were rated at eighty horsepower each and the engineer of the Committee had reason to believe that practically 160 horsepower would be available. A test, however, disclosed that only 110 horsepower could be developed, while the minimum required to operate the full capacity was estimated to be 150 horsepower. With 150 horsepower and a larger macerator. the full capacity of the plant could have been delivered. Since both these elements are standard equipment and can be obtained in various sizes on the market, the ultimate capacity of the plant can readily be obtained by simply substituting a macerator and power plant of greater capacity.

Costs

Based on the performance of the experimental combination plant and the estimated cost of an entirely new and remodelled plant, complete with an efficient power unit and larger macerator, the production costs and overhead charges of the unfinished peat per ton are estimated to be $2.00 and $2.48 respectively for a 10-hour day or $2.00 and $1.50 for a 20-hour day; or a total cost of finished peat fuel, on board cars at siding of plant of $4.48 for a ten-hour day for a season of 100 days, or $3.50 for a twenty-hour day or a total cost of finished peat fuel, on board cars at siding of plant of $4.48 for a ten-hour day for a season of 100 days, or $3.50 for a twenty-hour day during the same season. A total production of saleable fuel in the first case is 10,000 short tons and in the second, 20,000 short tons. Since, however, the overhead costs mount rapidly as the production decreases, the Committee recommend that plants of this type should be operated for twenty hours per day. The necessity for increasing the length of the working season by operating twenty hours per day will be readily appreciated, when it is realized that the considerable investment represented in plant is, under the most favourable conditions, lying idle practically two-thirds of the year. Thus the overhead would be distributed over the production of only one-third of a year, thus greatly increasing the cost. Working two shifts is equivalent to operating ten hours a day for 200 days. Night operation with this combined plant is entirely feasible: it was not the case with either of the others.

The foregoing costs are below that arbitrarily set by the Committee, as the maximum price at which peat could be sold f.o.b. plant and still compete with coal for domestic purposes. The most notable feature is the marked reduction in the total cost due to reduction in overhead, by operating for a season of two thousand hours instead of one thousand.

The important reductions in the final total cost will be attained by many improvements permitting of substantial saving in the construction of a new plant, and by the employment of a self-contained Diesel engine electric power plant. By using Diesel engines and electric generators and operating all drives on plant with electric motors, it is estimated that a saving of eighty-five cents per ton of saleable peat fuel will be realized, over that possible with the inefficient outfit employed this season. These figures assume the employment of this or some other equally efficient power plant. For a plant producing ten thousand tons, in 1,000 hours, a power equipment of 200 horsepower will be required. The following table recites the estimated costs of building an entirely new plant with power, harvesting, loading equipment, and other accessories. Overhead and administration charges are also shown.

TABLE OF NEW PLANT COSTS

Capital Costs	Interest	Depreciation		Administration
		Per Cent	$	
Power plant $25,000.00	7 per cent	10	2,500.00	10 per cent on $100,000.00 for 20 hrs. or 10 per cent on $50,000 00 for 10 hrs. daily operation
Peat plant $35,000.00		20	7,000.00	
Harvesting Equipment $25,000.00		14	3,500.00	
Buildings, Equipment and Miscellaneous $5,000 00		10	500.00	
Total $90,000.00	$6,300.00		13,500.00	$10,000.00 or $5,000.00

Market

A good market has been developed for peat within the economical shipping radius of the Alfred bog. The demand is growing. The success of such a plant depends in a marked measure, however, upon the site chosen for manufacturing in its relation to points of consumption. This should be selected with a view to eliminating long rail hauls. The economic limit depends not only upon freight rates, but on the price of other available competitive fuel. For example, the cost of anthracite to consumers has an effect upon the price at which peat fuel can be sold at the same point. It is the opinion of the Committee, that the price of peat fuel delivered to consumers should be in the neighborhood of $10.00 per ton if the bogs are strategically situated with respect to transportation facilities and within 100 miles of the market.

Plant No. 3, Small Peat Plant

When Plant No. 3, the small plant, was first designed an attempt was made to combine the excavating and macerating units in a single machine, simple in design and inexpensive. Until the end of the season of 1921 efforts were made to perfect the original design, but the results were not satisfactory. Difficulties with the combined excavator and macerator were not completely overcome and it was decided that other means of macerating must be found before this type of machine could be deemed practical from a commercial standpoint. About this time the possibilities of the Swing Hammer Pulverizer were brought to the notice of the Committee and nothing further was done with No. 3, until this machine had been tried out.

The "Swing Hammer Pulverizer" proved to be so superior to the type of macerator formerly used that it was decided to include it in the rebuilding of No. 3. This was carried out during the 1922 season. Construction, however, was only complete after the normal working season and, therefore, no sustained demonstration was possible. The troubles which developed in the first design were overcome. The capacity of No. 3 plant should be not less than one and one-half tons standard fuel per hour, and in regular operation might exceed this. The cost of construction cannot be given at this time as new drawings have to be prepared. It is, however, expected that it will not exceed $5,000.00. A full description of the redesigned machine with a discussion of its capabilities, and accurate figures of its cost, will be given in the final report of the Committee. Three men should be sufficient to operate it.

B. F. HAANEL, *Secretary*,
(Signed.) ARTHUR A. COLE, *Chairman*, *Peat Committee.*
R. C. HARRIS.

Toronto, December 5th, 1922.

INDEX VOL. XXXI, PART IV

PAGE
Alfred station 2
Anrep plant. *See* Plant No. 1 .
Anrep macerator 19
Anrep-Moore plant. See Plant No. 4 ....
Belt conveyor (Plant No. 2).
  And spreader (photo) 8
Belt conveyor. (Plant No. 4)
  Described 2-4
  In place for operation (photo) 3
  Another view, excavator in distance 5
Costs.
  Cubing 12, 13
  General 14
  Labour (q. v.)
  Jeffrey swing hammer shredder: purchase of engine to operate as against rental 24
  Labour: Plant No. 2 .... 12, 13, 16-18
  Overhead 16
  Reduction in 22
  Plant No. 2:
    capacity of machine 15, 16
    if driven by semi-Diesil engine 17
    if operated by self-contained steam plant 17
    production 12, 13, 16
  Interim report of Peat Committee on 27, 28
Cubing costs. (Plant No. 2) 12, 13
Distance travelled, Plant No. 2 .. 12, 13
Drying.
  Meteorological observations with reference to 22
  Moisture content 4
Farmers' Peat machine. *See* Plant No. 3.
Fire
  Loss of peat fuel through 19, 20
Fuel laid down 12, 13
Harvesting 10, 21, 22
Interim report of Joint Peat Committee 25-28
Investigation for 1922, outline of 22-24
Jeffrey Manufacturing Company of Montreal 19
Joliette Steel Company 21
Labour costs.
  Plant No. 2 .... 12, 13, 16-18
  Reduction in 22
Lost time 12, 13
Macerating 18, 19
Machinery and equipment.
  Reduction in costs 22
  Development of 25
Market 28
Meteorological observations *re* drying 22

PAGE
Minister of Mines (Federal Government) 5
Moisture content of Peat.
  Drying down 4
Moore, E. V. 5
Moore plant. *See* Plant No. 2.
Operations during 1921, improved plant. *See* Plant No. 4.
Operations, table of and costs 12
Ottawa and vicinity.
  Peat sales in 21
Overhead costs 16
Peat Committee.
  Findings of 1, 2, 25-28
  Refs. 5, 19, 20, 21
Percentage. (Plant No. 2).
  Lost time, unavoidable and avoidable 12, 13
Plant No. 1 (Anrep plant).
  Fuel Committee's findings on .. 1
  Relative merits of, and Plant No. 2 (Moore Plant) 10, 11
Plant No. 2 (Moore plant).
  Advantages claimed for 5
  Belt conveyor and spreader 8
  Conclusion reached at end of 1920 .... 10, 11
  Defects and drawbacks of 6, 10
  Difficulties encountered and improvements made 10
  Distance travelled 9, 15
  Drying field required for season's output 9
  Erection of plant on bog 6
  Harvesting 10
  In operation (photo) 8
  Novel features of 7
  One of the eleven caterpillar elements (photo) 6
  Operation and costs (table) 12, 13
  Peat fuel laid on field by (photo) 7
  Relative merits of, and Plant No. 1 (Anrep plant) 10, 11
  Speed of travel 15, 16
  Spreader: near view of, also cutting device 9
  Time lost 15, 16
  To be dismantled 24
  Trouble sheet (summary) 14
Plant No. 3 (Farmer's plant).
  Description, capacity, and labour 18, 23
  Ref. 2
Plant No. 4 (Anrep-Moore machine).
  Assembling and installation ... 2
  Belt conveyor system, excavator in distance (photo) 5

PAGE

Plant No. 4 (Anrep-Moore machine)—*continued.*
  Belt conveyor in place for operation (photo) ... 3
    another view ... 5
  Belt conveyor (portable) ... 2-4
  Costs ... 26-28
  Drying down ... 4
  General plan of operation for single unit ... 23
  Harvesting by ... 22
  Proposed operations of ... 22-24
  Ref. ... 12
  Spreader attached to belt conveyor (photo) ... 4

PAGE

Production (Plant No. 2) ... 12, 13
Sale of manufactured peat ... 20, 21
Spreader (Plant No. 2).
  Attached to belt conveyor (photo) ... 4
  Belt conveyor and (photo) ... 8
  Near view of; also cutting device ... 9
Storage of peat ... 20
Swing hammer shredder ... 19, 24
"Swing hammer pulverizer" ... 28
Trouble sheet, Plant No. 2 ... 14
  Wages. *See* Labour costs.
Working season ... 12, 13
  Economy of working two shifts 27

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES — THOS. W. GIBSON, DEPUTY MINISTER

THIRTY-FIRST ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXI, PART V, 1922

Natural Gas in 1921 - - 1—71
Petroleum in 1921 - - 72—76

By R. B. Harkness

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed by CLARKSON W. JAMES, Printer to the King's Most Excellent Majesty
1923

Printed by
THE RYERSON PRESS

CONTENTS

Vol. XXXI, Part V

PAGE
Letter of Transmission iv

NATURAL GAS IN 1921

General Conditions 1
Work of the Year 2
Orders issued 3
Percentage contract 3
Measurement of gas 4
Economy in using gas 5
New appliances for burning gas 7
Residue supply 7
Peak loads and their effects 8
Peak loads in cities and towns 13
Leakage 14
Improvements in the fields 15
Production 15
  Table I—Consumption in towns and cities 17
  Table II—Consumption in townships 18
  Table III—Classification by industries 20
Ratio of price to gas consumed 22
Operators licensed to produce natural gas, 1921 23
Operators licensed to drill or bore for natural gas, 1921 24
Operators licensed to operate natural gas pipe lines, 1921 24
PAGE
Operators licensed to distribute natural gas, 1921 25
Operators licensed to lease and prospect for natural gas, 1921 26
Field operations in 1921 26
  Table IV—Natural gas well drilled, 1921 27
Samuel S. Wyer's report 28
  Part 1.—Present natural gas situation 29
  Part 2.—How to keep natural gas industry alive 32
A new bailing machine 34
Gas wells in Lake Erie 36
General 37
Locating gas leak with match 37
Drillers' logs 38

PETROLEUM IN 1921

Table I—Crude petroleum production in 1921 72
Table II—Crude petroleum production by fields, 1917-1921 73
Drilling operations 73
Exploratory drilling 74
Shooting an oil well 75
Map of oil fields 75
Refining operations 76

ILLUSTRATIONS

PAGE
A battery of three orifice meters and a fourth auxiliary meter at Windsor 4
Dust trap for removing iron sulphate from natural gas 15
Bailing machine 35
One of the gas wells in Lake Erie near Port Alma, Tilbury East 37
The result of searching for a gas leak with a match or lamp 38
Modern (standard) drilling rig 74
The right way and wrong way of shooting an oil well 75

DIAGRAMS, CHARTS AND MAP

PAGE
Fig. 1—Diagram showing improper and proper distances between gas burner and bottom of cooking vessel 5
Fig. 2—Temporary methods of shortening distance between burners and cooking utensils 6
Fig. 3—Kent gas field showing past and projected future decline of volume and pressure 8
Differential pressure or rate of flow diagrams 9-12
Pressure and temperature charts, Sarnia, Windsor and Chatham ....*facing* 13
Past and estimated future rock pressure decline of Kent natural gas field 31
Diagram showing tubing holder for renewing leaky tubing in low pressure gas wells 35
Key map of Southwestern Ontario showing location and extent of Oil Fields, past and present, scale 5 miles to the inch ....*facing* 75

Letter of Transmission

Honourable H. Mills,

Minister of Mines.

Sir,—I have the honour to submit my report on Natural Gas and Petroleum for the year 1921. The full calendar year is covered in this report although the writer was not appointed until the passing of the Natural Gas Conservation Act on May 4th, 1921. Mr. E. S. Estlin, who resigned at that time, left sufficient information to discuss the first four months' operations in a general way, but the problems leading up to the passing of the Natural Gas Conservation Act, 1921, have necessarily been omitted.

The small number of complaints from the public and the improved conditions, both in production and distribution, as regards natural gas, indicate that the objects aimed at in the Act have been measurably achieved.

I have the honour to be, Sir,

Your obedient servant,

R. B. Harkness,

Commissioner of Natural Gas.

Office of the Commissioner of Natural Gas,
Toronto, 1922.

NATURAL GAS IN 1921

By

R. B. Harkness, Natural Gas Commissioner

General Conditions

The winter of 1920-1921 was unusually mild. There were only ten days in December and ten in January during which the temperature remained below freezing point for twenty-four hours; and only once in the whole winter did the thermometer register a drop below five degrees above zero.

The shortage of gas noted in previous reports had been taken as a warning, and consumers were advised by circular to put in a supply of coal, since a similar shortage could be expected for the coming winter. Manufacturers were denied the use of gas wherever possible, and restriction orders were issued for gas used for heating schools and public buildings. In some cases manufacturers and gas companies refused to acknowledge the authority of the Commissioner to issue such orders. There is no doubt that the acute shortage experienced during the winter of 1920-21 was directly due to the large quantities of gas used in industries and for heating large buildings. Wasteful appliances and leakage also contributed to the shortage as in past years, though conditions in these respects were improved as compared with the previous year. Windsor and Sarnia suffered more than Chatham, being farther from the field.

The Natural Gas Conservation Act, 1921, became law on May 4th, and contained a provision authorizing the varying of contracts in the interest of gas conservation for domestic use. Industries were at once instructed to change their equipment so as to use some other fuel wherever possible. These directions were generally obeyed; in some cases where they were not taken seriously, inconvenience was felt when the change had to be made later on short notice. Many manufacturers spent a great deal of money experimenting with other fuels, and a few were unable to find any other suitable for their needs. In these cases gas was allowed if only a small quantity was required. Some industries were permitted to use gas on giving up an equal quantity previously used for domestic purposes. In nearly every case the mayor and council of the town or city was consulted before depriving any industry of natural gas, when such action would probably lead to throwing men out of employment. Two large cities recommended that no industry whatever should be permitted to use gas, and most of the remainder recommended that only a selected list should receive such permission. Table No. III, page 20, shows how gas was distributed among industrial concerns. These measures had a marked effect at once, as will be seen on a study of the insert charts. These charts compare the gas pressure in the Tilbury field during the months of November and December, 1920, with the same months in 1921, and also the pressure for these months at the point where the Union Natural Gas Company delivers gas to the Windsor Gas Company for distribution in Windsor. A glance will show the great improvement in pressure at the Windsor end of the line, and it will be seen that whereas in November 1920, the pressure went below ten pounds on twenty-three days, in November 1921 it went below that point only on five days. In December 1920, pressure was below ten pounds on twenty-eight days, while in December 1921, only on eleven days, and in November and December 1921, the weather was, if anything, colder than in the same months of 1920. Similar graphs are given for Sarnia and Chatham, which show like results in a less marked degree, owing to their smaller population.

A remarkable feature is that the average pressure in the gas field was at least ten pounds greater in 1920 than in 1921, and at Windsor thirty pounds lower in 1920 than in 1921; indicating a greater demand in Windsor in 1920; which is borne out by the fact that the sales of gas in November and December, 1920, were twelve per cent. greater than in the same months in 1921. Again, on examining the Windsor low pressure chart on page 9, it will be noted that on Christmas Day 1920, the pressure at the consumer's gas range was as low as one-quarter of an ounce at one p.m., whereas on Christmas Day, 1921, it was slightly below one ounce at the same hour, and for nine hours averaged nearly four ounces higher than on Christmas Day, 1920, outside temperature being practically the same in both cases. While many complaints were received from citizens of Windsor in 1920, none were received in 1921; the reason being that the people used less gas but used it more carefully, thus enabling the gas company to maintain a higher pressure for the benefit of all. Undoubtedly the higher rate charged for gas in 1921 had also a material effect, but an examination of the graph shows that after each meal the pressure at the city limits increased slightly. As industries were not using gas to any great extent in 1921, this can only be interpreted as indicating that the lessened demand after the meal-time "peak load" allowed the pressure to build up for a time, and thereby improved the service.

Work of the Year

The winter months from January until March were fully taken up in distributing the inadequate supply of gas among consumers and industries, making inspections and investigating complaints. A survey of the Kent gas field was made by Samuel S. Wyer, natural gas expert and consulting engineer of Columbus, Ohio, and a report was submitted by him on May 29th, 1921. A copy of this report which is given on page 29 was sent to every one of the municipalities using natural gas in Ontario.

On June 1st, 1921, the Natural Gas Commissioner's office was moved from Chatham to 5 Queen's Park, Toronto.

The supplying of gas to the village of Fonthill and Pelham township, undertaken by Commissioner Estlin in October, 1920, the Relief Gas Company having become insolvent and unable to continue in business, was turned over to a committee representing these places on July 1, 1921. The pipe line and distributing plant of the Relief Company was subsequently sold, and Fonthill and Pelham are now being supplied with gas by the purchaser, R. G. Kerlin, of Hamilton.

During the month of August and at intervals in October and November the gas fields were inspected, and an attempt made to mark on the map the location of all wells drilled and all pipe lines in Ontario, also the owner of each. This was a heavy task, but much was done; most of the fields were inspected and many wells located on the map. This hasty inspection brought out the fact that some companies and most private well owners neglected their wells and allowed them to fill up with water. The correction of this condition had to be left over until 1922.

All hearings to adjust rates held by Geo. F. Henderson, Referee under the Natural Gas Conservation Act, 1921, were attended as follows:—

Chatham, July 11-14, 1921, application by Union Natural Gas Company; ditto Sept. 29 1921.

St. Thomas, November 23, 1921, application by Southern Ontario Gas Co.; ditto, December 8, 1921.

Aylmer, November 22, 1921, application by Central Pipe Line Co.; ditto, December 7, 1921.

Welland, October 5, 1921, application by Provincial Gas and Fuel Co.

At these hearings rates were fixed for most municipalities in Western Ontario.

Inquiries of an official and semi-official nature were held at Belmont, St. Catharines, London, Welland, Stevensville and Ridgeway.

Orders Issued

The following Orders were issued:—

Order No. 17: limiting the amount of leakage allowable on all pipes; providing for metering or measuring of all gas and for the inspection of consumers' appliances.

Order No. 18: prohibiting the use of gas without charge, and providing for compensation.

Order No. 19: imposing certain restrictions with regard to heating in public buildings, schools and churches.

Order No. 20: amending Order No. 18.

Most of the industrial plants using gas were inspected during the year, and when it was found that natural gas was being used where other fuel could easily be substituted, or could be used to better advantage, permission to use natural gas was withdrawn.

In the month of November the industrial gas situation in Chatham, Windsor and Sarnia was given special attention. The representatives of the industries and the mayors of these cities were met, conditions were very frankly discussed, and all assisted in finding a solution.

The remainder of the year was employed in various inspections in gas fields and distributing plants throughout the Province.

B. D. Burn, Inspector, has carried out his many duties most satisfactorily, these ranging from testing and adjusting gas stoves to plugging gas wells.

Percentage Contracts

It was recommended by Mr. Wyer (see report) that all percentage contracts should be abrogated at once. Consequently, on July 8th the Commissioner met the companies who paid for the gas they distributed on a percentage basis, and asked them to show cause why they should not pay for their gas at the point of junction of the high pressure mains with the distributing plant, so that the excessive leakage should be reduced to an attainable standard of 200 M cu. ft. per mile of three-inch pipe. The distributing companies all agreed to so improve their plants that the leakage would be kept at least up to this standard. They were given until July 1st, 1922, to make the necessary improvements and repairs.

Measurement of Gas

Large volume and high pressure orifice meters are in general use, and are indispensable to the natural gas industry. These meters give general satisfaction, and vary within the same small limits as the domestic meters commonly used in dwelling houses for measuring retailed gas. The meters installed in 1921, in compliance with Order No. 17, were as follows:—

ORIFICE METERS.

City of Windsor	3
Blenheim	1
Dresden	1
Tilbury gas field	5
Dover do.	1
Kingsville	1
Dundas	1
Total	13

A battery of three orifice meters and a fourth auxiliary meter at Windsor.

In addition, 54 positive meters were placed where short lines leave the high pressure mains. These meters check the quantity of gas entering the short lines against the quantity delivered to the consumers served therefrom. This work was begun in July, when the gas companies were assured of higher rates for their product, and was continued until the end of the year, some work remaining to be completed in 1922. Companies with very scattered gas wells and short pipe lines have been exempted from this requirement. All gas is measured in this way from the wells to the high pressure pipe line, from the high pressure pipe line to the distributing plant, and from the distributing plant to the consumer. All these measurements are reported monthly on a form supplied by the Department. The leakage reported is noted, and steps taken to curtail anything that seems to be excessive.

The result of this measure of control has been a marked decrease in the leakage of most distributing plants. The Wallaceburg Gas Company laid several miles of new pipe, and reduced its leakage from 4,900 cu. ft. per mile of three-inch pipe per annum to 2,969 cu. ft. By reason of the fact that gas companies read meters every day in the month, any one month's figures will also include some gas used in the previous month; consequently it will require one year to obtain definite information as to the total reduction of this waste by leakage. Another result of the campaign against leakage is that it has been found that the pressures carried on distributing systems are higher than necessary, and on several plants the pressures are being lowered. The largest cities now using natural gas are being supplied at two to four ounces, but there is still much room for the reduction of pressures generally.

Economy in using Gas

An effort has been begun to teach the general public how to use gas more economically. The gas companies were directed (Order No. 17) to inspect and adjust appliances, recommend changes in the same where necessary, and generally explain how economies could be effected. A set of directions showing in detail and by means of cuts how to arrange burners so as to obtain the best service when the pressure drops, was sent by the Department to every consumer of natural gas, These directions originated in Ohio State University, Columbus, Ohio, and are reproduced below.

In burning gas for cooking three distinct steps are necessary:

(a) The gas must be properly burned; that is, it must be properly mixed with air so as to burn with a pale blue non-luminous flame. A luminous flame will be wasteful and will deposit soot on the cooking vessel.

(b) The flame must be properly directed, that is, the tip of the flame must come close to the cooking vessel. If the flame is too short to reach the cooking vessel, or is blown to one side by a strong draft of air, gas will be wasted, a longer time will be required, and if the flame tip is too far away it may be impossible to cook, although the short improperly directed flames may be kept burning a long time.

(c) The heat generated by the burning gas must be delivered through the cooking vessel walls and into the food. Hence, thin vessels and grid or open stove tops are necessary for good service. Natural gas should never be used under a solid stove top because it is always wasteful and under low pressure conditions may make cooking impossible.

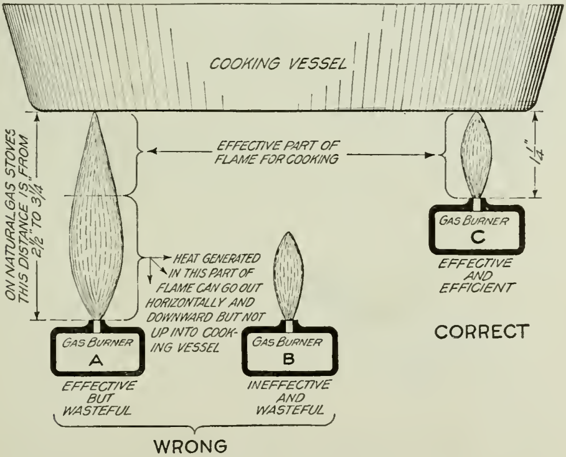

COOKING VESSEL
ON NATURAL GAS STOVES THIS DISTANCE IS FROM 2½" TO 3¼"
EFFECTIVE PART OF FLAME FOR COOKING
1/4"
GAS BURNER C
EFFECTIVE AND EFFICIENT
CORRECT
HEAT GENERATED IN THIS PART OF FLAME CAN GO OUT HORIZONTALLY AND DOWNWARD BUT NOT UP INTO COOKING VESSEL
GAS BURNER A
EFFECTIVE BUT WASTEFUL
GAS BURNER B
INEFFECTIVE AND WASTEFUL
WRONG

Fig. 1.—Diagram showing improper and proper distances between gas burner and bottom of cooking vessel.

A and B in the illustration (Fig. 1) show what happens when low pressure natural gas is burned in the usual natural gas stove. Position B shows cooking vessel so far away that the short flames cannot reach it, resulting in waste of gas, longer time to cook, and in some cases impossibility to cook at all, even though the gas may be burned for a long time. In A, two-thirds of the flame does not reach the bottom of the vessel, i.e., this gas is wasted.

Merely lowering the cooking vessel or raising the burner, as shown at C in Fig. 1, will result in satisfactory cooking, in the usual length of time with same low pressure, same stove and same burner. In fact, properly directed short flames at low pressure, as shown at C, will actually use less than one-half of the gas required with the usual high pressure and resulting long flames.

Correct Position of Burner and Vessel.

For permanent service in purchasing new stoves, get either an artificial gas stove or a natural gas stove with burners properly raised for short flame service. Old stoves worth remodeling may be changed by:

(a) Raising the burner, burner supports, and manifold—that is, pipe into which gas burner cocks are screwed.

(b) New burner castings of proper height for short flames may be secured for some stoves.

(c) Cementing casting on top of existing burners so as to bring the burner top to the proper height.

(d) Depressed grid tops to bring the vessel support down to the low burners.

Closed tops should never be used and in all cases where burners are raised, grid or open tops must be used with the short flames.

A larger sized spud opening—that is, the small opening immediately in front of the gas cock through which the gas passes into the mixer—should be used with low pressure service. Some stoves have adjustable spuds; others must either have new spuds or have the old small openings reamed larger.

If the pressure in the gas mains is too high, the more efficient short flame low pressure conditions can still be maintained by merely partially opening the gas cock. Never let the flame lick up along the side of the vessel.

Baker burners need not be raised, because the heat from the burning gas is already inside of the chamber to be heated. The spud and mixer must, however, be properly adjusted so as to get a pale blue non-luminous flame.

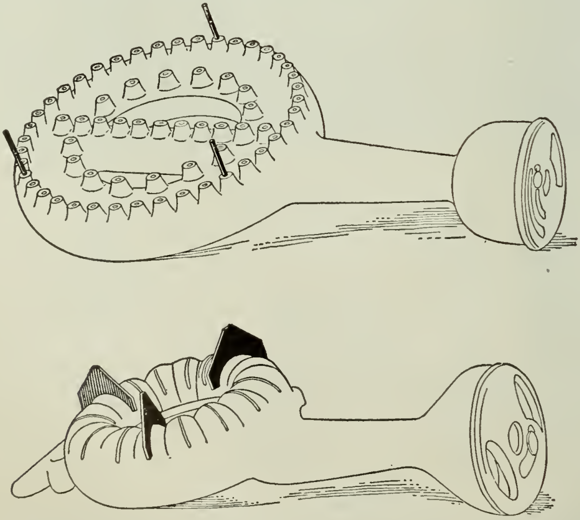


Fig. 2.—Temporary methods of shortening distance between burners and cooking utensils.

As a temporary means, remove the stove top and on drilled burners insert three wire nails and on slotted burners, three pieces of sheet iron, for supporting the cooking vessel as shown above, so that the tip of the short low pressure flame comes close to the vessel bottom.

After the boiling point is reached, much gas can be saved by turning down the flame.

Dirty gas burners always prevent proper cooking operations.

New appliances for burning Gas

At the suggestion of two of the gas companies a large stove manufacturing firm has designed and placed on the market a stove specially suited for burning "sulphur" gas, or in fact any kind of gas, with greater economy. A demonstration of the qualities of this stove was given at Windsor and the appliance pronounced a decided success. When it is considered that a large majority of the appliances used for burning gas are old coal and wood stoves converted into gas burners, the advantage and saving that may be derived from a specially designed apparatus can readily be seen. For example, a test made on an old coal stove showed it to consume five cu. ft. as against one cu. ft. in a gas stove with an open top. This means that the old stove is depriving four families of gas, also that one-fifth of the bill is for gas used in cooking, and four-fifths for gas wasted. Of course, with "sulphur" gas, an open top stove cannot be used. It will be interesting to note what the saving effected by the new stove will be. Undoubtedly, some of the heat must go up the chimney, but if the housewife is careful to turn out the gas when she removes the vessel, and to turn the gas down or use a "simmerer" when the water begins to boil, (for water cannot be raised above 212 degrees Fahr. no matter how hard the kettle boils) she would at once notice a difference in the gas bills. The matter of raising the burners to 1¼ to 1½ inches below the bottom of the vessel has been so often urged that it needs no further discussion. An experiment carried out at Ohio State University showed that the average cook wasted eighty-five per cent of the heat in any ordinary gas stove. Surely it is time that the general public seriously studied how to use the remaining supply of natural gas to the best advantage.

Residue Supply

The quantity of gas in any gas field is easily calculated, provided the original rock pressure, present rock pressure, and the total volume of the gas that has been drawn or has escaped from the wells are known. Naturally the records must be carefully kept or the result will fall short of accuracy.

In the Kent gas field a fair record of rock pressures has been kept for a number of years, and computations have from time to time been made. The total volume of gas originally in the field was 190,000,000,000 cu. ft. This and the quantities used each year are shown in graphic form. Figure 3. Although theoretically the decline in rock pressure and the decline in volume should follow the same line, it is practically impossible to record either with sufficient accuracy to make them identical. However, the result is on the whole satisfactory.

The projected future supply is taken from Mr. Wyer's report, where it was shown in terms of rock pressure. By noting on the chart the quantity of gas that may be consumed each year, it is clearly seen that instead of increasing the number of consumers and the number of industries to be supplied with gas, these numbers must be reduced each year, or the supply of natural gas cannot last for the length of time given by Mr. Wyer. It is encouraging to note that this essential fact is finding its way into the consciousness of many people, and that not a few consumers are beginning to render assistance by curtailing the use of gas where other fuel can be substituted.

Many people are still of the opinion that there is plenty of gas for all. To show how small a quantity of gas has to serve the people of eighty-two townships, it might be well to mention that in the city of Toronto during the year 1921, 5,500,000,000 cu. ft. of gas was manufactured for use in that one city, whereas the total production in the same year by 1,922 gas wells in an area of approximately 6,000 square miles was only 8,532.234,000 cu. ft.

Peak Loads and their Effects

The supply of gas available for any locality is determined by:—

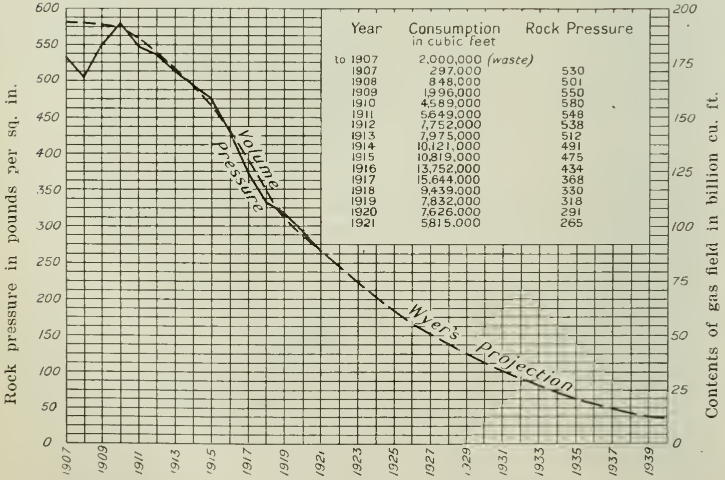
1. The number of gas wells and their rock pressure (i.e., the volume of gas in pounds per square inch which was placed by nature in the microscopic cavities between the sand grains of the rock reservoir).

2. The length and size of the pipe line from the gas field to the place of consumption.

In a city supplied with manufactured gas these two factors are represented by:

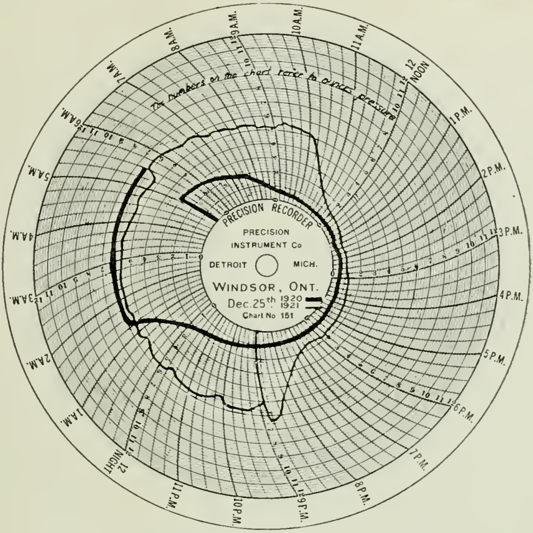
(1) The capacity of the producer plant.

(2) Size of the gas holder.



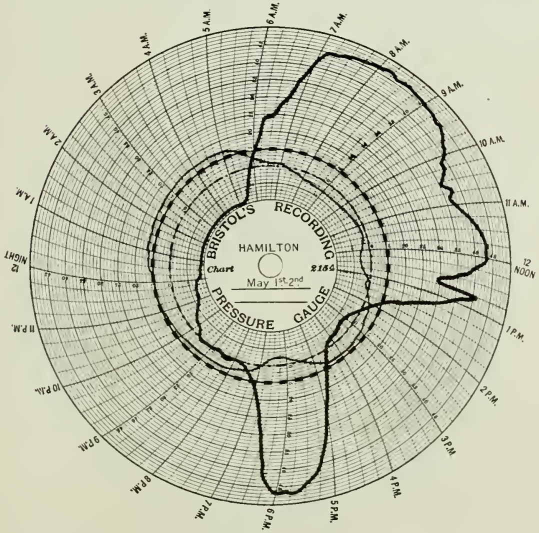
Year	Consumption in cubic feet	Rock Pressure
to 1907	2,000,000 *(waste)*	
1907	297,000	530
1908	848,000	501
1909	1,996,000	550
1910	4,589,000	580
1911	5,649,000	548
1912	7,752,000	538
1913	7,975,000	512
1914	10,121,000	491
1915	10,819,000	475
1916	13,752,000	434
1917	15.644,000	368
1918	9,439,000	330
1919	7,832,000	318
1920	7,626.000	291
1921	5,815.000	265

Fig. 3.—Kent gas field showing past and projected future decline of volume and pressure.



——— Ounces Pressure, Christmas day, 1920.

——— Ounces Pressure, Christmas day, 1921.

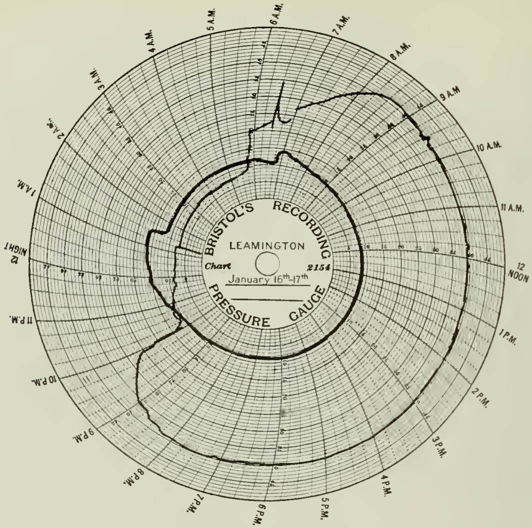


——— Differential pressure or Rate of Flow under Peak Load conditions.

——— Lbs. Pressure of Gas at the Orifice Meter under Peak Load Conditions.

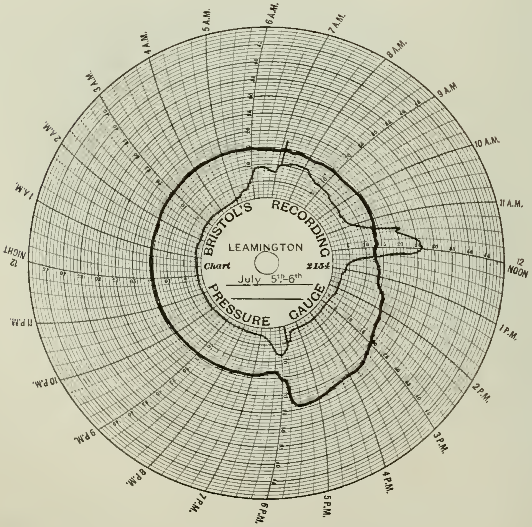
- - - - Rate of Flow if the demand were constant and no Peak Load.

—·—·— Lbs. pressure of gas necessary to supply such constant demand.



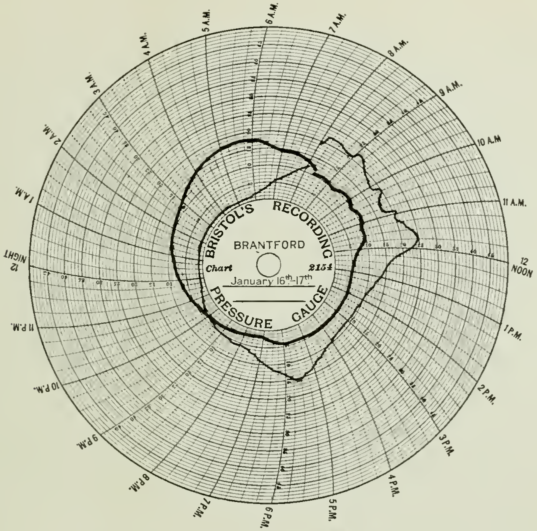
—— Pressure in the High Pressure Gas Mains.

—— Differential Pressure or Rate of Flow in Winter.
The Meter is measuring the full capacity of the Plant for 13 hours.



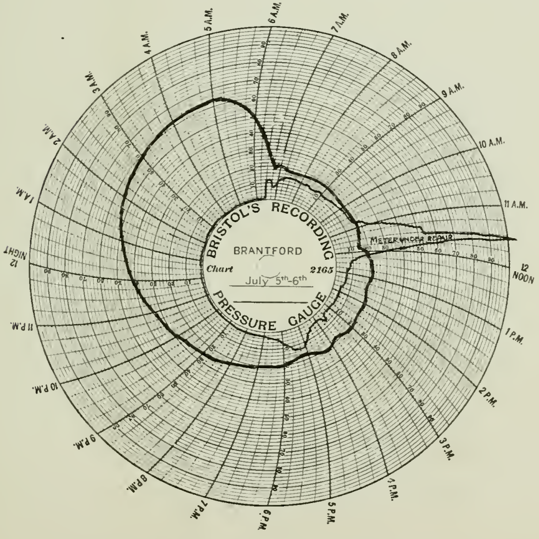
—— Pressure in the High Pressure Gas Mains.

—— Differential Pressure or Rate of Flow in Summer.



━━ Pressure in High Pressure Gas Mains.

—— Rate of Flow or Winter Demand in Brantford. It does not differ so very much from summer demand.



━━ Pressure in the High Pressure Gas Mains.

—— Rate of Flow or Demand in Brantford in Summer.

In municipalities only a few miles from the gas field a short pipe line must be packed with gas at a very high pressure, whereas for a municipality a long distance from the field, a long pipe line will hold the same volume of gas at a much lower pressure, and as the pressure on a short line is quickly lowered, more gas wells must be held in reserve to keep up the supply to a nearby municipality than would be required for the one farther away. This can readily be seen by comparing the graphs (see inserts) showing the comparative pressures to Sarnia, Chatham and Windsor. Sarnia and Chatham have nearly the same population, yet there is a much greater variation in pressure at Chatham than at Sarnia.

The same reasoning will show that the distant municipality will get a better and more even service with a lower pressure than the near-by one, but, unfortunately, when the rock pressure becomes very low the demand for the near-by municipality is so great that gas wells must be held in reserve to turn on when the pipe line pressure drops below the minimum necessary for maintaining a supply, and as a result the distant municipality is bound to suffer a shortage.

As the rock pressure in the gas field falls from year to year, peak loads on the near-by municipalities will become more serious, and in the attempt to maintain a good service in such municipalities, those at a distance must suffer for the reason pointed out in the preceding paragraph.

The question of determining when the distant municipality must be finally deprived of its natural gas service is dependent upon the economies that the near-by municipalities will practise.

An examination of the three graphs (inserts) showing pressures at Windsor, Chatham and Sarnia, and the pressure-volume charts, pages 9 to 12, will show that in the early morning the gas pressure begins to drop, and that after six o'clock at night the pressure rises, although between these hours in the past winter the pressure showed signs of recovery. This is explained by the fact that much less gas was being used in the industries last winter than in the one previous, and that between the hours for preparing meals the supply of gas was greater than the demand, thus permitting a rise in the gas pressure. Such an effect, however, is only noticeable on a few occasions, as the demand for heating is so great that only on warm days can any relief be expected.

Peak Loads In Cities and Towns

In cities where very little gas is used for heating purposes and the greater demand is for cooking, the peak load is most in evidence. The orifice meter chart for the city of Hamilton, page 9, shows this peak load. It will be seen that the gas pressure drops from 5 a.m. until 12.30 p.m., recovers from 12.30 p.m. until 4.30 p.m., drops until 6.30 p.m., and recovers until 5 a.m. The differential pressure, which indicates the volume or "rate at which gas flows" shows practically no gas being used from midnight until 5 a.m. The breakfast cooking demand, causing a sudden rush which lasts until 9 a.m., the lesser quantity of gas used between breakfast and noon for baking, washing, etc., the sudden increase again at 11 a.m. until 12 noon, the practical cessation of the demand again until 4.30, when another rise begins culminating at 6 p.m., unmistakably reflect the daily programme of domestic life in the homes of Hamilton gas consumers. To deliver the volume of gas required to cook the meals in a city of 200,000 people requires an efficient system of distribution. The quantity of gas passing through the orifice meter is 1,035,000 cu. ft. in twenty-four hours, and practically all of this gas was used in the daylight hours. If the demand had been uniform during the twenty-four hours, and the same amount of gas passed through the meter, the differential pressure or "rate of flow" would have followed the broken line, and the pressure might have been reduced to ten pounds, as shown by the —.—. line.

Turning to the charts for Leamington, Brantford and St. Catharines, it will be noticed that the noon "peak" is very pronounced in both summer and winter in both Brantford and St. Catharines, while in Leamington there is a uniform daylight load in the winter, and the mealtime "peaks" are in summer. The explanation of this is that the price of gas in Brantford and St. Catharines is higher than in Leamington, and very little is used for heating, while in the latter place, with a lower price, there is a great demand for heating. Still another reason is that the distributing plants of Brantford and St. Catharines have pipes of sufficient size to deliver gas at a four-ounce pressure, while in Leamington the pipes are much too small to supply the demand and pressures vary from ten to twenty-two ounces. The pipes in this town will be enlarged and relaid in 1922, and an improvement in the service will then undoubtedly be noted. Comparing the total load, it will be seen that the St. Catharines consumption on a winter day is 675,000 cu. ft., as against 209,000 cu. ft. in summer, or over three times as much. In Brantford it is 515,000 cu. ft. in winter as against 299,000 cu. ft. in summer, little gas being used for heating in Brantford, while in Leamington the winter consumption is 1,031,000 cu. ft. as compared with 160,000 cu. ft. in summer, or over six times as much. These quantities are calculated by applying a formula and constant multiplier to the line pressure and the differential pressure shown in the chart.

A distributing plant must be designed to deliver all the gas demanded at times of peak loads, and from this it can be clearly seen that if no gas is being used during the night and very little between meals, the gas plant is lying idle and yielding no return about sixty per cent. of the time, hence the rate the consumer pays for gas must be proportionately higher than if there were a constant demand during the twenty-four hours and no peak load. This is further shown by the broken line on the Hamilton chart. The statement is quite as true of transmission lines as it is of distribution plants.

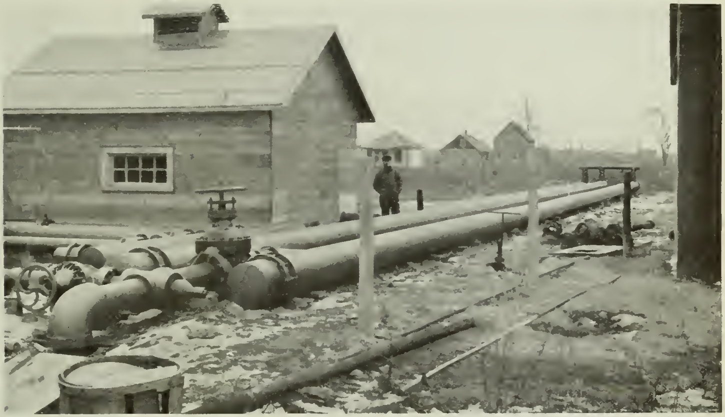
Leakage

It had been hoped to thoroughly discuss the important question of leakage in this report, but on account of the late installation of orifice meters and the fact that there is no check on some companies to date, it would be obviously unfair to single out those companies which are lowering the leakage on their pipe lines and distributing plants, while those which have not yet accomplished much escape notice. Suffice it to say that the leakage on nearly all pipe lines and distributing plants is more than it should be. In some private lines seventy-five per cent. of the gas escapes, and in other pipe lines the loss varies down to permissible and accepted standards of leakage. In every practicable way pressure is being brought to bear on companies and individuals to check this excessive leakage.

Improvements in the Fields

Among the improvements in the methods of transmitting and distributing gas in Ontario during the year 1921, mention may be made of a "dust" or sediment trap, and the installation of a number of large volume orifice meters.

In long distance transmission of natural gas containing sulphuretted hydrogen, it was found increasingly difficult to keep regulators and meters in good condition as the distance from the field lengthened. Investigation proved that the difficulty was due to a deposit of fine dust which clogged some of the working parts and caused excessive friction in others. The dust was found to be iron sulphide which formed in these long pipes, and was carried along with the gas.



Dust trap for removing iron sulphate from natural gas.[1]

To remove this dust, the complicated apparatus shown in the photograph was installed. Two lengths of eighteen-inch pipe, each 140 feet long, were laid parallel and tied together at each end by a slightly smaller pipe, and all joints oxyacetylene-welded. The gas enters through an eight-inch pipe into the two eighteen-inch pipes, and the rate of flow is reduced about ten times. This slowing up allows the iron sulphide dust or sediment to settle, and the gas passing up and through the connecting pipe at the distant end of the eighteen-inch pipes to the orifice meters shown on page 4, is almost entirely freed from the dust. This was put in operation in the late autumn, and gave every satisfaction during the winter when it had its most severe test. The estimated total cost of this plant comprising dust trap and orifice meters installed is about $5,500.

Production

The production of natural gas during the year 1921 was 8,532,234,000 cu. ft., which is 2,015,254,000 cu. ft. less than in the previous year. These figures do not include leakage. The falling off in production is due to three causes:

---

[1] Photo supplied by Union Natural Gas Co., Ltd., Chatham, Ontario.

(1) The natural decrease in the quantity of gas which will come out of the rock owing to decrease in the gas pressure.

(2) The many restrictions enforced by the Commissioner in the sale of gas for manufacturing purposes.

(3) The increase in the price of gas, and consequently the more careful use of this valuable fuel.

The total value of gas produced, taken from the returns of the companies, was $2,975,502. Some companies value their output at the price paid them by the companies which distribute the gas, hence the above valuation is at best approximate, being based partly on wholesale and partly on retail prices. The average retail price in 1921 was about forty-five cents per M cu. ft.

Comparing last year's sales with those of 1920, we have the following comparison:—

In 1920:

75,000 domestic consumers used	9,121,000	M cu. ft.
5,000 commercial consumers used	1,424,000	"
Total	10,545,000	"

In 1921:

87,108 domestic consumers used	7,674,493	M cu. ft.
1,000 (estimated) commercial consumers used	857,741	"
Total	8,532,234	"

Omitting the city of Hamilton, where the natural gas is mixed with manufactured gas, there were in 1921, 65,962 consumers using 7,116,032 M cu. ft., an average of 107,000 cu. ft. per consumer, which compares very favourably with the average quantity used at that price on this continent.[1]

Although it is possible that the number of domestic and industrial consumers reported in 1920 was in part estimated, yet even if the number of domestic consumers was the same in both years they used 1,446,507 M cu. ft. of gas less in 1921 than in 1920, and the improvement in service is clearly seen in this report. This is ground enough upon which to base the statement that the methods adopted for conserving the natural gas supply are in the interest of the public.

Below is a table giving particulars regarding the consumption of natural gas in cities, towns and villages during 1921. It shows the quantities used for ordinary domestic purposes, also in industrial operations, the prices paid, and other particulars. This is followed by a table giving similar information with respect to the use of gas in township municipalities.

---

[1] Rep. Ont. Dept. Mines., Vol. XXX, 1921, Pt. 5, p. 13.

TABLE I.—CONSUMPTION OF NATURAL GAS IN TOWNS AND CITIES, 1921.

City, Town or Village	Population[1]	No. of consumers		Amount used in 1921 M. cu. ft.			Distance from gas field, miles	Rate, cents per M. cu. ft.
		Free	Pay	Free	Pay	Industrial		
Aylmer	2,094		742		45,539	369	12	60&75
Bridgeburg	2,401	3	974	499	60,876	174	8	50&75
Fort Erie	1,546							
Belmont			140		6,492		94	75
Blenheim	1,565		516		68,027	576	20	45
Belle River	608		149		17,306	1,092	29¾	45
Brantford	29,440		4,537		152,544	5,318	141	80
Chippawa	1,137	4	72	500	2,642		3	40
Caledonia	1,223		426		50,753	4,934	6½	40&45
Courtright	448		217		25,389	1,236	53¼	45
Chatham	13,256		3,600		564,182	47,135	22	45
Cayuga	784		209		27,456			45
Dunnville	3,224	5	916	373	109,136	13,962	12	42&45
Dundas	4,978		1,041		38,377	873	172	70
Delhi	733		246		20,764	1,264	26	45
Dresden and Tupperville	1,339		527		61,034	16,724	30	45
Dutton	813		269		34,424	1,226	52	30
Essex	1,588		412		55,544	15,046	33	45
Fonthill	600		150		8,933		25	70
Galt	13,216		1,572		73,002	2,637	147	80
Hamilton	114,151		21,146		55,846	61,578	166	
East Hamilton			413		16,828		27	75
Highgate	394		124		18,802	20	32	20
Hagersville	1,169		365		33,712		13¼	50
Hepworth	317		20		1,250		½	50
Ingersoll	5,150	1	1,225	124	99,342	6,112	100	80
Jarvis	485		240		31,688	2,129	9	43
Kingsville	1,783		576		80,284	107,802	30	40
Leamington	3,675		1,135		182,959		20	40
Niagara Falls	14,764		2,878		132,782	561	11	50&70
Oil Springs	490	15	140	1,000	7,912	1,806	1	75
Petrolia	3,148		820		107,982	4,158	60	50
Paris	4,368	1	641	171	31,363	375	129	80
Rodney	756		240		32,754	148	40	28
Ridgetown	1,855		637		74,106	12,543	28	45
Sarnia	16,135		3,950		522,924	13,161	55¼	40&50
Simcoe	3,953		1,501		206,508	9,757	20	45
St. Catharines	19,881		3,414		161,810	2,395	35	75
Thorold	4,825		445		24,565	62,418	30	75
Merritton	2,542							
Tilbury	1,673		402		47,532	15,744	13½	35
Tecumseh	978		133		15,448		50	45
Tillsonburg	2,974		930		76,507	3,204	14	47
Vienna	288		131		13,198			45&65
Welland	8,654	3	1,959	282	91,826	705	3	50&70
Sandwich	4,415		470		60,786		43¼	40&50
Ford	5,870		440		56,907		43¼	40&50
Walkerville	7,059		1,403		174,972	6,482	43¼	40&50
Windsor	38,591		7,209		918,593	13,768	43¼	40&50
Wallaceburg	4,006		1,100		139,627	209,690	27½	40&50
Wheatley	378		142		18,868		3	25
Woodstock	9,935	1	2,150	117	112,316	5,036	108	80
West Lorne	755		208		30,306	576	45	28
Port Colborne	3,415		1,241		102,838	9,133		50
Humberstone	1,524							
Port Rowan	672		250		21,366		3	52
Port Dover	1,462		474		52,929	9,787	29	45
All Gas Companies for power purposes						140,816		
Total		33	75,263	3,066	5,677,365	812,470		

[1] From Dominion Bureau of Statistics, 1921 Census.

TABLE II.—CONSUMPTION OF NATURAL GAS IN TOWNSHIPS, 1921.

Townships	Population	No. of consumers		Quantity used in 1921, M. cu. ft.			Rate, cents per M. cu. ft.
		Free	Pay	Free	Pay	Industrial	
Essex County—							
Gosfield North	1,977	4	117	147	16,310	....	36&89
Gosfield South	2,427	......	415	....	57,851	....	36&89
Maidstone	2,225	12	471	2,291	59,838	....	45
Rochester	1,911						
Sandwich South	1,391						
Sandwich West	3,519						
Sandwich East	2,348						
Mersea	3,356	......	132	....	17,540	....	30
Tilbury North	1,699	2	181	364	22,560	3,548	45
Tilbury, West	1,533						
Lambton County—							
Enniskillen	3,063	....	667	....	77,861	....	45
Moore	3,320						
Sombra	2,865						
Sarnia	2,583	1	11	21	1,800	....	45
Euphemia	1,543	......	20	....	6,667	....	25
Kent County—							
Raleigh	4,343	168	1,537	54,934	245,284	35,165	17&35
Dover	4,345						
Tilbury East	3,197						
Romney	1,563						
Harwich	4,124	17	688	6,979	112,026	100	17, 25 & 45
Orford	1,814						
Howard	2,507						
Chatham	5,272	2	33	565	3,480	....	45
Camden	2,021	......	8	....	960	....	45
Elgin County—							
Aldboro	2,906	5	28	429	3,324	....	25
Dunwich	2,581	3	122	302	14,623	579	40
Southwold	3,211	1	163	52	26,203	3,465	505
Malahide	2,748	......	65	....	5,428	....	35&7
Bayham	3,438	8	356	1,337	33,291	....	35, 42, 47&65
Middlesex County—							
Westminster	5,258	......	247	....	24,134	....	66&70
Dorchester North	3,104	......	137	....	12,199	480	60&70
Norfolk County—							
Houghton	1,165	......	15	....	966		47
Middleton	2,057	7	7	2,143	418	....	42
Walsingham	2,553	9	98	1,126	7,940	....	52
Charlotteville	2,492	6	114	1,322	9,796	....	45
Windham	2,950	3		586			45
Woodhouse	1,669	17		2,385			45
Brant County—							
Onondaga	1,134	10	206	1,572	12,560	....	45&80
Dumfries South	2,391	......	140	....	7,288	94	80
Oxford County—							
West Oxford	......	......	7	....	341	....	80

TABLE II.—*Continued*

Townships	Population	No. of consumers		Quantity used in 1921, M. cu. ft.			Rate, cents per M. cu. ft.
		Free	Pay	Free	Pay	Industrial	
Haldimand County—							
Canborough	997	46	76	7,551	6,783	....	42½
Moulton	1,609	34	87	6,116	7,861	....	25&60
Seneca	1,742	67	136	10,634	11,699	....	30&45
North Cayuga	1,423	15	35	2,776	3,856	....	35
South Cayuga	591	28	59	5,737	4,616	....	42½
Rainham	1,731	105	272	21,366	29,705	....	25
Sherbrooke	316	1	26	250	2,661	....	40&50
Dunn	788	27	115	2,814	12,188	....	20&42
Walpole	3.311	46	297	8,481	29,265	1,131	26&45
Oneida	1,377	10	69	1,331	7,399	....	40&50
Welland County—							
Wainfleet	2,582	42	117	7,027	6,655	....	35&70
Humberstone	2,304	58	158	11,709	6,885	....	50
Bertie	3,305	85	1,041	17,071	38,044	485	60
Pelham	2,600	5	136	1,110	9,000	....	57
Thorold	2,885	1	153	169	9,161	....	50&70
Willoughby	917	38	53	7,904	1,824	....	50&70
Crowland	3,826	29	58	5,179	3,956	....	50
Stamford	4,000	......	239	....	8,222	....	50&70
Lincoln County—							
Caistor	1,300	32	28	5,041	4,880	....	25&42½
Gainsboro	2,117	1	42	50	2,314	224	35&75
Grimsby	2,879	41	140	12,147	8,310	....	75
Louth	2,312		10		710	....	57
Grantham	3,456	1	17	881	1,200	....	57
Wentworth County—							
Binbrook	1,260	37	86	6,799	13,049	....	25&42½
Glanford	1,409	9	84	1,452	9,356	....	25&42½
Barton	10,165	......	923	....	73,614	....	40
Flamboro West	2,423	......	34	....	1,258	....	70
Ancaster	4,058	......	1	....	1,326	....	25
Total	....	758	4,492	143,595	315.797	1,840	....

These two tables of gas consumption in the cities, towns and townships of Ontario is not given as correct in detail. In procuring the data for the same, it was found difficult to segregate gas users in one township from those in an adjoining one, or in a group of townships, the gas companies not finding it necessary to keep a separate ledger for each township. Again, many houses and small gas engines may be supplied with gas passing through the same meter, and on account of the relatively small consumption, this gas has been classed as for domestic use. The number of consumers is probably correct, but the quantity of gas consumed may in some cases not be so. This applies more particularly to country and village users. In cities and large towns separate ledgers are usually kept, and more precise figures are available. The tables, however, approximate the true situation and show where most gas is used, and also how the price affects the quantity consumed. It will be noted that the total gas consumed as shown in the tables is not the same as the total quantity of gas produced in 1921. This is explained by the fact that no private wells are included and no leakage.

TABLE III.—CLASSIFICATION BY INDUSTRIES OF NATURAL GAS USED IN ONTARIO FOR INDUSTRIAL PURPOSES IN 1921 (1)

Municipality.	Factory Heating, Incinerator.	Gas Engines and Power	Soldering, Hardening metals, Tempering, Annealing	Enamelling	Laundries, Tailors, Cleaners,	Printing	Packing, Canning	Heating glue wax, water, etc.	Bakers, Confectioners, Restaurants	Dairies	Laboratories	Glass Mfg., Tobacco Curing	Clay Workers, Lime kilns	Greenhouses	Total (M. cu. ft.)
Aylmer		273							96						369
Belle River		658	67						367						1,092
Belmont		161							101						262
Blenheim		263				70			241				2		576
Brantford		1,042	2,014	883	100	106		78	1,005				90		5,318
Bridgeburg								123							123
Caledonia	3,591	432							911						4,934
Chatham		7,984	9,150	2,045		1,914	1,093		5,060	3,798			16,091		47,135
Chatham district		7,880				110			958				13,802		22,750
Coatsworth		332											11,214		11,546
Comber		1,020							380				2,148		3,548
Courtright		1,236													1,236
Delhi		1,264													1,264
Dresden		16,112							612						16,724
Dundas		194	679												873
Dunnville		9,574	3,111							1,277					13,962
Dutton		723							503						1,226
Essex	334	7,785							1,583		168		5,176		15,046
Fort Erie		51													51
Galt		93	1,705	145				694							2,637
Hamilton		82	(3) 28,598	7	63		355	1,793	331	7,887	108		22,354		61,578
Highgate		20													20
Ingersoll		1,387	112				297	150	4,166						6,112
Jarvis		2,129													2,129
Kingsville		39,133	379		1,457	63	401		1,621	652		(4) 48,861		15,246	107,802
Muirkirk		100													100
Niagara Falls			519					52							561
Oil Springs		1,806													1,806
Paris		80						295							375
Petrolia		1,545			353				1,349				911		4,158
Port Colborne				9,133											9,133
Port Dover		607	91			448							8,171	470	9,787
Prairie Siding		869													869

Putman		218													218
Ridgetown		1,595	2,818		231				1,052	86			8,761		12,543
Ridgeway		182													182
Rodney		148													148
Sarnia district		3,947												233	4,180
Sarnia		4,505	1,308		331	241			1,558	1,038					8,981
Selkirk		1,131													1,131
Simcoe		51					7,065	2,273		368					9,757
St. Catharines			2,395												2,395
St. George		94													94
Shedden-Fingal		3,465													3,465
Stevensville		303													303
Thorold												62,418			62,418
Tilbury		14,472					147		835				198	92	15,744
Tillsonburg		576	338					14	2,276						3,204
Wallaceburg		72,277	1,181			207			2,276			133,746	3		209,690
Walkerville	(2) 1,287		3,439	236				139	1,149			132			6,382
Welland					592	113									705
Wellandport	118	87								19					224
West Lorne	126	380					70								576
Wallacetown		579													579
Windsor			2,858	1,906	21	226	332	2,713	5,475	94	243				13,868
Woodstock			843		491	520		186							5,036
All Gas Companies		140,816													140,816
Total (M. cu. ft.)	5,456	349,650	61,605	14,355	3,639	4,018	9,760	8,500	36,640	15,219	912	245,025	86,921	16,041	857,741

(1) The quantities are in thousand cubic feet. (2) Incinerator. (3) Annealing—14,412 M. cu. ft. (4) Tobacco Curing.

Ratio of price to Gas consumed

At the various rate hearings during the year 1921, it was stated several times that the rates charged for gas had very little to do with conserving gas. A glance at Tables I and II will show at once that it has very much to do with conserving gas. For instance:

Place	No. Consumers	Rate cents	Amount used, M. cu. ft.	Average per Consumer M. cu. ft.
4 Townships in Kent County	168	Free	54,934	321
"	1537	35 and 17	245,284	160
Dutton..................	269	30	34,424	128
Dundas.................	1041	70	38,377	37

These places have been taken at random. Averaging all places where rates are equal may give a slightly different result.[1] The comparison is only made to show that careless use of gas does exist, and that the steps taken to curtail needless consumption of gas are justified. Surely there is no need of anyone using 321,000 cu. ft. of gas when his neighbour has the same result from 160,000 cu. ft.

When the price of gas is advanced beyond fifty cents apparently other fuels come into competition for heating purposes, but where the price of gas is below fifty cents it is undoubtedly used for all purposes. The degree of care used in conserving gas will be seen to decrease in direct proportion with the decrease in price.

There is also a rate above or below which profits decrease. One company puts this maximum rate at eighty cents.

It has often been stated that electricity is a cheaper and better fuel for cooking than natural gas. A glance at the number of consumers, rate, and amount of gas used in Niagara Falls, where electricity is cheapest, should be sufficient to convince the most skeptical that this is not correct.

It is of considerable interest to know for what particular purposes natural gas is used, in industrial or manufacturing operations. There are certain trade and even agricultural operations for which gas is so convenient and advantageous a fuel, as compared with any other, that it is difficult to deny them the use of gas if it can at all be spared. Table III classifies by industries the industrial uses of gas in 1921.

---

[1] Ont. Dept. of Mines, Vol. XXX, Pt. 5, p. 13.

The following list gives the names and addresses of operators licensed to produce natural gas in 1921:—

OPERATORS LICENSED TO PRODUCE NATURAL GAS, 1921

License No.	Name	Address
105	Aldrich Gas & Oil Co.	Bruce & Counsel, Hamilton, Ont.
122	Beer, George	Binbrook, Ont.
130	Beaver Oil & Gas Co., Ltd	Brantford, Ont.
137	Bertie Natural Gas Co	Ridgeway, Ont.
139	Battle Natural Gas Co	Sun Life Bldg., Hamilton, Ont.
142	Binbrook Gas Co	N. Laidman, Binbrook, Ont.
134	Castle Oil & Gas Co., Ltd	Niagara Falls, Ont.
141	Chippawa Development Co	Chippawa, Ont.
148	Chippawa Oil & Gas Co	Tavistock, Ont.
129	Coleman, J. A.	Wellandport, Ont.
118	Canfield Natural Gas Co	W. W. Thompson, Canfield, Ont.
104	Canby, B. F.	R.R. No. 2, Marshville, Ont.
147	Canboro Gas & Oil Co., Ltd	Selkirk, Ont.
110	Darling Road Co-op. Co., Ltd	Canfield, Ont.
146	Dunn Natural Gas Co	Dunnville, Ont.
131	Dominion Natural Gas Co	Brantford, Ont.
115	Empire Limestone Co.	191 Hudson St., Buffalo, N.Y.
144	Emerson, Laidlaw, Troughton	R.R. No. 1, Attercliffe Station, Ont.
127	Glenwood Natural Gas Co	638 Ellicott Sq., Buffalo, N.Y.
108	Hamilton Gas & Oil Co	17 Main St., E. Hamilton, Ont.
145	Hendee Gas Co	Cayuga, Ont.
119	Industrial Natural Gas Co	Thorold, Ont.
116	Jasperson, B.	Kingsville, Ont.
124	Lalor & Vokes	Dunnville, Ont.
123	F. R. Lalor	Dunnville, Ont..
112	Lamb, A.	Selkirk, Ont.
143	Midfield Natural Gas Co	9 Maple Ave., Hamilton, Ont.
136	Medina Natural Gas Co	Chatham, Ont.
135	Marshall, James	Hamilton, Ont.
132	National Gas Co	Hamilton, Ont.
106	North Shore Gas Co	c-o Bruce & Counsel, Hamilton, Ont.
121	Northern Gas & Gasoline Co	Hepworth, Ont.
125	Ontario Gypsum Co	Paris, Ont.
109	Oil Springs Oil & Gas Co.	Oil Springs, Ont.
113	Provincial Natural Gas Co	Niagara Falls, Ont.
117	Port Colborne-Welland Natural Gas Co.	Port Colborne, Ont.
103	Pilkington Bros	Thorold, Ont.
133	Petrol Oil & Gas Co	1804 Royal Bank Bldg., Toronto, Ont.
140	Richmond Gas Co.	Chatham, Ont.
138	Sparham, A. F.	R.R. No. 1, Caledonia, Ont.
120	Sterling Natural Gas Co	Port Colborne, Ont.
114	Stevensville Gas Co	Stevensville, Ont.
111	Sundy Gas Well Co	J. Ralston, Dunnville, Ont.
126	Union Natural Gas Co	Chatham, Ont.
128	United Gas Companies	St. Catharines, Ont.
107	Vacuum Oil & Gas Co., Ltd	608 Lumsden Bldg., Toronto, Ont.

The individuals, firms and companies duly licensed to drill or bore for natural gas were:—

OPERATORS LICENSED TO DRILL OR BORE FOR NATURAL GAS, 1921

License No.	Name	Address
50	Berry & Anderson	Caledonia, Ont.
63	J. A. Coleman	Wellandport, Ont.
66	Chamberlain, H. A	Shelburne, Ont.
70	Clover Gas & Oil Co., Ltd.	Raymond & Spence, Welland, Ont.
68	Featherstone, C. W	Canboro, Ont.
69	Featherstone, C. W	Canboro, Ont.
71	Hoover & May	Selkirk, Ont.
58	Industrial Natural Gas Co.	Thorold, Ont.
72	Imperial Oil Co., Ltd	56 Church St., Toronto, Ont.
56	Jasperson, Bon.	Kingsville, Ont.
64&65	Kiser & Louer	Tillsonburg, Ont.
59	McCutcheon, T. J	Dunnville, Ont.
60	McLister, J. J	Dunnville, Ont.
57	McKillop, Wm.	Hepworth, Ont.
55	Provincial Nat. Gas & Fuel Co.	Niagara Falls, Ont.
51,52&53	Snively, F. L.	90 Melrose Ave., Hamilton, Ont.
67	Stover, F. H.	110 Canfield Ave., E. Detroit, Mich.
54	Universal Gas & Oil, Ltd.	c-o Millar, Ferguson & Hunter, Crown Life Bldg., Toronto, Ont.
62	Union Exploration Co., Ltd	Chatham, Ont.
73	Featherstone, C. W.	Dunnville, Ont.
87	McKechnie, Sam	Dunnville, Ont.

Companies operating pipe lines under license were as follows:—

OPERATORS LICENSED TO OPERATE NATURAL GAS PIPE LINES, 1921

License No.	Name	Address
24	Beaver Oil & Gas Co	638 Ellicott Sq., Buffalo, N.Y.
26	Castle Oil & Gas Co	Niagara Falls, Ont.
27	Central Pipe Line Co	Chatham, Ont.
25	Dominion Natural Gas Co	638 Ellicott Sq., Buffalo, N.Y.
23	Glenwood Natural Gas Co	Brantford, Ont.
19	Northern Pipe Line Co	Chatham, Ont.
21	Southern Ontario Gas Co	638 Ellicott Sq., Buffalo, N.Y.
22	United Gas Companies	St. Catharines, Ont.
20	Union Natural Gas Co., Ltd	Chatham, Ont.

Distributors of natural gas duly authorized to carry on operations in 1921 were as follows:—

OPERATORS LICENSED TO DISTRIBUTE NATURAL GAS, 1921.

License No.	Name	Address
98	Azoff Natural Gas Co.	c/o A. Baker, Canfield, Ont.
99A	Beer, George	Binbrook, Ont.
112	Bertie Natural Gas Co	Ridgeway, Ont.
91	Belmont Gas Light Co	Belmont, Ont.
96	Brantford Gas Co.	Brantford, Ont.
105	Beaver Oil & Gas Co.	Brantford, Ont.
114	Binbrook Gas Co.	Binbrook, Ont.
103	Coleman, J. A.	Wellandport, Ont.
111	Central Pipe Line Co.	Chatham, Ont.
115	Chippawa Development Co.	Chippawa, Ont.
89	Corp. Town of Leamington	Leamington, Ont.
83	Chatham Gas Co.	Chatham, Ont.
110	Castle Oil & Gas Co.	Niagara Falls, Ont.
112	Chippawa Oil & Gas Co	c/o A. E. Ratz, Tavistock, Ont.
104	Dominion Natural Gas Co.	638 Ellicott Sq., Buffalo, N.Y.
119	Dunn Natural Gas Co.	Dunnville, Ont.
88	Fisherville Gas Co.	c/o Chris. Held. Fisherville, Ont.
120	Gas & Oil Co., of Springvale.	c/o W. B. Shoup, Hagersville, Ont.
102	Glenwood Natural Gas Co.	638 Ellicott Sq., Buffalo, N.Y.
121	High Grade Natural Gas Co	c/o R. L. Pattinson, Chatham, Ont.
92	Industrial Natural Gas Co.	Thorold, Ont.
107	Ingersoll Gas Light Co.	Ingersoll, Ont.
117	Lake Shore Natural Gas Co	294 Baynes St., Buffalo, N.Y.
123	Kerlin, R. G.	234 Lister Bldg., Hamilton, Ont.
113	Midfield Natural Gas Co	9 Maple Ave., Hamilton, Ont.
100	Manufacturers Gas Co	638 Ellicott Sq., Buffalo, N.Y.
93	Northern Gas & Gasoline Co	Hepworth, Ont.
84	Oil Springs Oil & Gas Co.	Oil Springs, Ont.
85	Petrolia Utilities Co.	Petrolia, Ont.
86	Provincial Natural Gas & Fuel Co., Ltd.	Box 55, Niagara Falls, Ont.
87	Port Colborne-Welland Gas Co	Port Colborne, Ont.
95	Rosehill Natural Gas Co	c/o G. A. Halbin, Department of Assessment, 15 City Hall, Buffalo, N.Y.
94	Sterling Gas Co.	Port Colborne, Ont.
109	Sarnia Gas Co.	Sarnia, Ont.
118	Shetland Gas Co.	c/o L. H. Badgeley, Florence, Ont.
97	Southern Ontario Gas Co.	638 Ellicott Sq., Buffalo, N.Y.
99	Union Natural Gas Co., Ltd.	Chatham, Ont.
101	United Gas Companies.	St. Catharines, Ont.
116	United Gas & Fuel Co.	Hamilton, Ont.
90	Windsor Gas Co.	Windsor, Ont.
108	Wallaceburg Gas Co.	Wallaceburg, Ont.
106	Woodstock Gas Light Co.	Woodstock, Ont.

The following list contains the names and addresses of those to whom licenses were issued to lease lands for gas purposes, and to prospect for gas in 1921.

OPERATORS LICENSED TO LEASE AND PROSPECT FOR NATURAL GAS, 1921.

License No.	Name	Address
92	Abray, Thomas	Highgate, Ont.
76	Beaver Oil & Gas Co., Ltd	Buffalo, N.Y.
86	Bermingham, T. F	55 John St., S. Hamilton, Ont.
59	Bunn, Forest	Ruthven, Ont.
81	Castle Oil & Gas Co., Ltd	Imperial Bank Bldg., Niagara Falls.
68	Clover Gas & Oil Co., Ltd	1711 Main St., Buffalo, N.Y.
75	Dominion Natural Gas Co., Ltd	638 Ellicott Sq., Buffalo, N.Y.
73	Frontier Oil & Gas Co., Ltd	211 Liberty Bldg., Buffalo, N.Y.
72	Glenwood Natural Gas Co., Ltd	638 Ellicott Sq., Buffalo, N.Y.
90	Irvine, J. J	Victoria Hotel, Dunnville, Ont.
89	Inland Oil & Gas Co., Ltd	Kent Bldg., Toronto, Ont.
67	Industrial Natural Gas Co	Thorold, Ont.
84	Jasperson, Bon	Kingsville, Ont.
77	Keyser, Bert L	21 London St., Toronto, Ont.
70	Milkins, H. R., Jr	R.R. No. 2, Leamington, Ont.
69	Minor, L. E	Smithville, Ont.
63	Maple Leaf Oil & Gas Co., Ltd	14 Brisbane Bldg., Buffalo, N.Y.
78	Petrol Oil & Gas Co., Ltd	1804 Royal Bank Bldg., Toronto, Ont.
65	Provincial Natural Gas & Fuel Co., Ltd.	Box 55, Niagara Falls, Ont.
61	Pilkington Bros., Limited	Thorold, Ont.
66	Progressive Gas & Oil Co., Ltd	38 Sun Life Bldg., Hanilton, Ont.
79	Quillinan, J. A	Drawer 110, Niagara Falls, Ont.
88	Robnett, C. W	Merlin, Ont.
80	Symes, H. D	Imperial Bank Chambers, Niagara Falls, Ont.
82	Snively, F. L	90 Melrose Ave., Hamilton, Ont.
93	Staehling, E. H	Merlin, Ont.
94	Smith, R. H	Lowbanks, Ont.
95	Sparham, A. F	Caledonia, Ont.
91	Smith, H. B	117 Oak Ave., Windsor. Ont.
60	Thames Oil & Gas Co	24 Adelaide St., Toronto, % T B. Malone.
64	Universal Gas & Oil, Ltd	Crown Life Bldg., Toronto, Ont.
71	Union Exploration Co., Ltd	Chatham, Ont.
83	Valley Oil & Gas Co	42 Home Bank Bldg., Hamilton, Ont.
85	Western Counties Gas Co	Bradford & Bradford, Dunnville, Ont.
62	Winger, S. W	R.R. No. 4, Hagersville, Ont.
74	Williams, A	Leamington, Ont.
87	Wiles, Chas. H	R.R. No. 2, Dunnville, Ont.

Field Operations in 1921

The field operations for the year 1921 are shown in the following table, which indicates the efforts that are being made to locate and open up new reservoirs of gas, and the degree of success attending them.

Table IV shows the field operations for the year. It is gratifying to compare this record with that for 1920, when out of a total of 94 wells drilled 21 were dry and 73 produced in daily open flow only 9,203,000 cu. ft.

TABLE IV.—NATURAL GAS WELLS DRILLED, 1921

County	Township	Number of Wells Abandoned in 1921	Number of Dry Wells Drilled in 1921	Producing Wells Drilled in 1921		Number of Producing Wells on Dec. 31st, 1921
				Number	Open Flow	
					cu. ft.	
Brant	Onondaga	4				53
Bruce	Amabel					2
Elgin	Aldborough	1				
	Bayham	1		1	75,000	56
	Malahide		2	1	200,000	1
Essex	Gosfield S			1	17,000	1
	Mersea			1	25,000	4
Haldimand	Canboro	6		4	201,000	158
	Cayuga North		3	4	538,435	44
	Cayuga South	1				62
	Dunn	1		1	100,000	20
	Moulton	2		7	266,000	91
	Oneida			9	763,000	23
	Rainham	9				122
	Seneca	7	3	28	3,030,000	161
	Sherbrooke	1	1	2	280,000	14
	Walpole	16	2	4	225,000	157
Kent	Dover West	1	2	1	60,000	8
	Raleigh	3		1	1,000,000	24
	Romney	2				95
	Tilbury East	13	1	12	4,288,000	147
Lambton	Dawn	1		1	177,000	1
	Enniskillen					4
	Euphemia					6
	Sarnia	3		11	2,400,000	14
Lincoln	Caistor	13				50
	Gainsborough	1				2
Middlesex	Nissouri West					3
Norfolk	Charlotteville	1				14
	Houghton	3				2
	Middleton			2	273,000	17
	Walsingham N.			2	126,000	6
	Walsingham S.			1	18,000	15
	Windham					5
	Woodhouse	4		3	245,000	63
Welland	Bertie	6		8	2,860,000	97
	Crowland			3	325,000	50
	Humberstone	5				118
	Wainfleet	1				55
	Willoughby	4	1			51
Wentworth	Binbrook	2	3	6	197,000	71
	Barton					2
	Beverley		1			
	Flamboro West		1			
	Glanford	3	1	1	30,000	28
Total		114	21	115	18,716,435	1915

Note:—Gas wells drilled into the gravel beds above the rock are not included. The Table comprises 72 private wells, but no doubt this is short of the total number.

The shortage of money in 1920 certainly had much to do with limiting drilling operations, but the appointment of a Referee under the Natural Gas Conservation Act, 1921, with powers to fix rates had much more to do with encouraging operations in 1921. A number of independent companies who sell their gas to pipeline companies commenced work, one company drilling as many as 15 wells, 14 of which were producers. The real effect of this new legislation will be seen in 1922, as many companies were not ready to start work before cold weather set in, acquiring leases and financing having occupied most of the year.

It is regrettable that the total number of wells in operation in all fields and their rock pressures has not been recorded in past years. If this had been done the life of the old Welland-Haldimand field might have been gauged, but it is impossible to get enough information to predict its future in graph form as has been done with the Kent field (see Figure 3). It will be noted, however, that the number of wells drilled in 1921 is very much less than the number abandoned, and that the open flow of new wells averages 129,000 cu. ft., whereas ten years ago this would have been considered very low.

Without definite facts one can only sound the warning, CONSERVE.

The future of Ontario's gas supply is in new fields. The known fields have more than enough wells draining them at present. More exploration and deeper exploration must be carried out, or there will not be enough gas sold to make it profitable to maintain the long pipelines in Ontario at present. True enough, some deep drilling has been done and results are none too encouraging, but the tests are scattered and very little has been done to correlate the work of the different companies. Thorough survey of the work done in the past, and careful tabulation of the information gained, should be a useful guide in the search for new gas fields. It is hoped that this work may be undertaken in 1922.

The usual amount of drilling was carried out in the old fields excepting the fields in Bruce county and Oil Springs, where the limits of the present fields appear to have been reached.

Mr. Bon Jasperson tested a new field in Essex county with indifferent success.

The Union Natural Gas Company discovered a new deep field in Dawn township after two failures.

The Sarnia Gas and Oil Company has discovered a new gas field in Sarnia township at shallow depth. The wells have only a moderate production.

The Dominion Natural Gas Company has found a new field at Lakeview at the expense of some dry holes.

The Provincial Natural Gas Company has discovered a small body of gas under high pressure at Point Abino on the edge of the almost exhausted Welland field that has been producing gas for 33 years. Unfortunately there is space for only three wells in this small area.

The Valley Oil and Gas Company drilled a well at Dundas with a very small show of gas and oil, and in a second well at Copetown found such deep and difficult surface that the well had to be abandoned at 537 feet. The company is extending its operations in 1922.

Samuel S. Wyer's Report

In the spring of 1921, in view of the conflicting opinions freely expressed regarding the volume of gas remaining in the Kent county gas field—the principal gas area of Ontario—and its bearing on fair and reasonable prices for gas, the government of Ontario decided to have an examination and report made on the same by an impartial and competent expert. It was agreed on all sides that Samuel S. Wyer, consulting engineer of Columbus, Ohio, a recognized authority on natural gas, possessed the requisite qualifications and experience, and he was accordingly commissioned to undertake the task.

The text of Mr. Wyer's Report, in which he deals in an illuminating way with the present and future of the natural gas situation in Kent county, is as follows:—

HON. HENRY MILLS,
Minister of Mines,
Toronto, Ontario.

Dear Sir:

In accordance with your instructions, I have made a personal inspection and analysis of your natural gas situation in the Kent Field in Western Ontario, and find the following:

1—Since 1910, average rock pressure has declined from 570 to 256 pounds.
2—There is no justification whatever for making open flow volume test of wells, because of needless gas waste.
3—The transmission and distribution leakage is excessive, and should be curtailed.
4—The percentage contracts for sale of gas are against public policy, and should be abrogated at once.
5—Meters should be installed to measure gas into and out of all transmission lines.
6—Domestic consumers waste enormous quantities of gas through improper appliances.
7—All gas using appliances should be inspected at once by gas companies.
8—The use of wasteful appliances should be prohibited.
9—All extensions to merely maintain service should be paid for out of operating expense and not capitalized.
10—A just retail price can be fixed only by paying an adequate return on the present fair value of natural gas properties.
11—The immediate carrying out of these recommendations is imperative in order to cope with the cold weather conditions of next winter.

Respectfully submitted,

SAMUEL S. WYER.

Columbus, Ohio.
May 31, 1921.

Part I.—Present Natural Gas Situation

(1) *Misleading Nature of Open Flow Data.*—The term "open or natural flow" refers to the entiire volume of gas that will come from the mouth of a gas well when blown directly into the atmosphere and retarded only by atmospheric pressure.

The custom of exploiting original open flow capacities of natural gas wells in "cubic feet" rather than in "M" cubic feet, and without any regard to actual delivering possibilities, alone has led to grossly misleading impressions. Thus for a popular "million cubic foot well":

	In 24 Hours.
Original open flow capacity	1,000,000 cu. ft.
Gas for market is always measured and sold in units of 1,000 cu. ft. Thus in terms of marketing units, this 1,000,000 cu. ft. represents only	1,000 "M" cu. ft.
Because of operating limitations, not more than 25% of the open flow capacity can generally be delivered from the average natural gas well. This reduces the actual marketing units of the "million cu. ft. well" to	250 "M" cu. ft.

The well capacity will decline from the beginning of gas removal until the expiration of the well's life. The rate of decline in the earlier period of the well's life will generally be much more marked than in the latter part. Therefore, the average output of a 1,000,000 cu. ft. well, even under Canada's longer cold weather conditions, will be about .... 140 "M" cu. ft.

(2) *Significance of Rock Pressure.*—When nature generated or deposited the natural gas in the rock reservoir—made up of the microscopic cavities between the sand grains—a fixed amount of gas was placed in a fixed inclosed space. The pressure in the rock—called "rock pressure"—was the result of the pressing into this fixed space of a larger volume of gas than the mere free air capacity of this rock reservoir. The degree of compression employed by nature in the formation process determined the intensity of the resulting pressure in the reservoir.

As the gas is removed, the rock pressure and volume must decline, because there is no regeneration, and only a fixed amount of gas was placed in the reservoir, and if a part of this fixed volume is removed the remaining gas volume expands and keeps the reservoir completely filled——except as water intrusion interferes—but at a lower pressure. Rock pressure decline is, therefore, inevitable whenever any gas is removed, and the average rate of decline for a number of wells is generally a much better index of the amount of gas left than any data pertaining to any relative open flow capacity at different periods.

The rock pressure decline in the past—based on data collected by your department—is shown on the next page, as well as my estimates for future decline under conservation and adequate price operating conditions. The average rock pressure of 260 wells measured in May, 1921, was 256 pounds.

The importance of refinements in rock pressure data have been much exaggerated. The practical problem is how to best use the residue gas that remains. Variations of a few pounds either way are of no consequence now.

The desirability of obtaining rock pressures with surrounding wells shut in has been much over-stressed. Wells are not operated on this basis, and the actual rock pressures determined under average operating conditions are more dependable as an index of the true condition.

(3) *Gas Merely an Incident of Oil Prospecting.*—It is not generally appreciated that natural gas is found primarily as a by-product in the search for oil. This is due to the fact that the oil industry does not have any public utility obligations and can be handled with much less capital than is required for natural gas, and the average prospector would very much prefer to find oil rather than gas.

(4) *No Holding Back of Supply.*—There has not been any holding back of the natural gas supply in the field, as has been alleged. It is, of course, obviously true that where a main pipe line leaves a field to supply a large number of consumers, that the gate valves of the lateral lines close to the field cannot ordinarily be kept wide open if service is to be rendered to all of the towns, because the towns nearest the field would take all of the gas and not leave any for the towns further away.

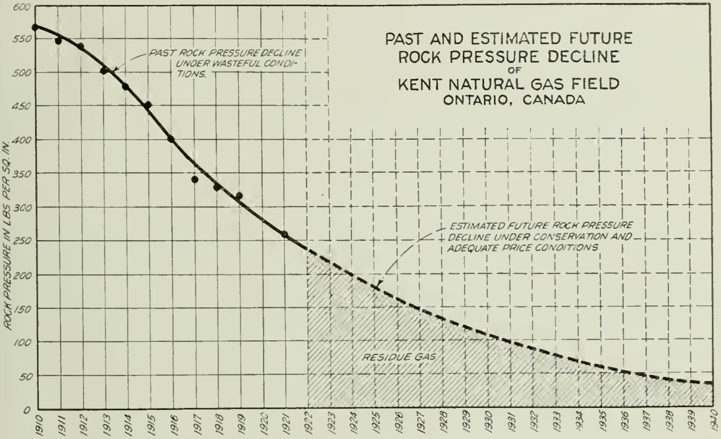
(5) *Water Pumping.*—The intrusion of water in the gas sand makes the field operating conditions especially troublesome. The methods now in use for removing the water with mechanical pumps rather than by blowing wells, are to be commended. This water problem obviously increases the operating costs.

(6) *Sulphur Problem.*—The high sulphur content of the gas gives it an offensive odor, but does not interfere with the heating value of the gas; that is, for heating purposes the gas has the average number of heating units per cubic foot. The offensive odor has some advantages in that it makes the detection of gas leaks very much easier, and the leakage condition with the high sulphur gas should be very much better than the average. This has not been realized in practice due to the negligence in handling the gas.

(7) *Waste in Production.*—Much gas has been needlessly wasted in unnecessary well blowing. There can be no justification whatever for blowing wells merely to determine the open flow capacity, because the rock pressure decline data, which can be secured without any waste of gas, give a much better index of the future serving possibilities. This is such a serious matter that your department should prohibit open flow blowing except where it is necessary to test wells for water conditions.

Many of the gate valves in the field are leaking badly, and there is much gas lost along the field lines and around the rural consumers' premises.

(8) *Waste in Transmission.*—Due to the lack of measuring data in the field, there is no definite check as to the amount of gas put into the transmission lines. Meters should be installed, not at each individual well, but at groups of wells, so as to get a definite basis of measurement of the amount of gas delivered to the transmission lines.



(9) *Waste in Distribution.*—The waste in distribution is excessively high. Much of the gas is sold through percentage contracts; that is, where the natural gas is delivered to the local distributing plant and then sold to the local distributing company on the basis of a certain percentage of the income from the ultimate consumers' meters, without any definite limitation as to leakage conditions of the local distributing company's plant, through which the gas must be passed to be marketed or delivered to the ultimate consumer. These percentage contracts should be abrogated at once, for the reasons given in Section 14.

The leakage should be reported in terms of "1,000" cu. ft., of gas lost per annum per mile of equivalent 3-inch pipe.[1]

The criminal waste in some of the distributing plants is obvious from the following comparison:

	Annual Unaccounted for Gas Per Mile 3-Inch Pipe in "1,000" Cu. Ft.
Good manufactured gas practice	100
Ohio Fuel Supply Co.'s own distributing plants in Ohio, aggregating 60,000 consumers	190
Standard fixed by United States District Court[2] of Kansas, December 22, 1920, as attainable	200
Sarnia, Ontario Distributing plant	590
Chatham, Ontario distributing plant	4,800
Wallaceburg, Ontario distributing plant	4,900

The distributing pressures carried are higher than desirable for good service. See Section 20.

(10) *Waste in Natural Gas Use.*—Due to poor appliances, the average domestic consumer wastes much more gas than he uses. Much gas is wasted in leakage, improper combustion, and burning of gas for a longer period than is necessary. The use of gas in coal burning appliances is always grossly wasteful, and natural gas should be used only in appliances designed especially for gas. The waste in hot water tank heating and in cooking is exceptionally large, as is shown by the abnormally high consumption of gas in hot summer months when the heating load is off.[3]

(11) *Why Natural Gas Supply is Short.*—The demand is now greater than the available supply. The supply will become less each year and cannot be increased. The demand must be curtailed to meet the constantly decreasing supply available.

---

[1] Sizes other than 3-inch are converted to 3-inch by multiplying by the ratio of the respective diameters. That is, one mile of 6-inch would be equivalent to two miles of 3-inch, and one mile of 1½-inch would be equivalent to one-half mile of 3-inch.

[2] 269 Federal Reporter, p. 433.

[3] For further discussion see Technical Paper 257 "Waste and correct use of natural gas in the home." United States Bureau of Mines, Washington, D.C.

The leakage in the field in transmission and distribution is excessive and must be curtailed, if continuity of service for the future is to be secured.

The consumers' methods for use of gas in the home are grossly wasteful. With efficient use the same service can be secured with a very much smaller volume. The peak load demand in winter time for heating load fluctuates with the temperature, that is, as the temperature goes down the demand for gas increases very rapidly, and during low temperature periods this demand is greater than the serving possibilities of the supply. For this reason, not only must efficient appliances be used, but the heating load must be rapidly curtailed.

Part II.—How To Keep Natural Gas Industry Alive

(12) *Natural Gas Industry Has Reached Crisis.*—Your natural gas industry reached the peak of its production in 1917, and has declined since that date. It is now in a rapid transition stage, and unless immediate steps are taken to bring about a complete re-organization of the methods of production, transmission and use, the industry can live for but a very few years. The only way the industry can be made to continue to function is to place it on a conservation basis. That is, curtail waste in production transmission, distribution and use. If the facts are faced fairly, squarely and immediately, a solution can be worked out which will produce satisfactory natural gas service for many years. If the facts are not met immediately, then early liquidation of the industry is inevitable. Speed in applying remedial measures is therefore the essence of the present situation.

As to what per cent. of the total residue gas can be saved will depend on the price. That is an adequate price is the crux of the gas conservation question. Furthermore, the important feature now is not to bother with what has happened in the past, but to handle the residue supplies still available in the most efficient manner.

(13) *Substitutes for Natural Gas.*—Natural gas is the ideal fuel for domestic purposes and should be saved for this service. The value of natural gas will be best appreciated by comparing it with the quantities of substitutes required to furnish the same heating energy.

	Amount required to equal "1,000" cu. ft. natural gas.
Manufactured gas	2 "M" cu. ft.
Acetylene	200 lbs. calcium carbide.
Gasoline	8 Imperial Gallons.
Kerosene	7 Imperial Gallons.
Alcohol	12 Imperial Gallons.
Electricity	322 K.W. Hours.

In tests made in the Department of Home Economics, The Ohio State University, Columbus, Ohio, it was shown that $1.00 natural gas, used under low pressure conditions with properly directed short flames, was cheaper than any other fuel that could be secured.[1]

(14) *Percentage Contracts Must Be Eliminated.*—The vicious features of the percentage contract are not in the fact that the gas is sold by the local distributing company on a mere percentage of the total receipts through the ultimate consumers' meters, but in the fact that the wholesale company must first stand all of the leakage in the local distributing plant, and, secondly, that this places no incentive whatsoever on the local distributing company to keep its plant tight, and is the major reason for the deplorable leakage conditions that now exist in distributing plants selling natural gas on a percentage basis. That is, because of these percentage contracts a premium is actually placed on inefficient operation, and the local distributing plant is so operated as to actually stimulate a wanton waste of a limited natural resource, and in so doing greatly injures the public.

Where percentage contracts are in use the following invariably will happen:

a—Collections by the local distributing company will not be as carefully looked after as when the local distributing company is entirely responsible for and the sole loser of unpaid bills.

---

[1] For further discussion see "Kitchen tests of relative cost of natural gas, soft coal, coal oil, gasoline and electricity for cooking" made by the Department of Home Economics, The Ohio State University, Columbus, O., June, 1917.

b—The waste in leakage will always be much greater than where there is a definite responsibility. Most natural gas distributors fail to appreciate that constant vigilance is the price of a tight natural gas plant, and if they are not responsible for the tightness of their plant little or no vigilance will be exercised in curtailing leakage.

Much has been said about the sacredness of contracts, without appreciating that there can be no vested right to do a moral wrong. These percentage contracts are not private contracts, but are public contracts in which the public has a vital interest, and when one recklessly, defiantly, persistently and continuously wastes natural gas, and boldly declares his purpose to continue to do so, he ought not to complain of being branded as the enemy of mankind.

The distributing and wholesale companies should be given two weeks in which to abrogate these objectionable percentage contracts and if they do not agree, then a governmental agency should step in immediately and declare that the contracts are against public policy and should void them in the interest of the public.

(15) *Gas Must Be Measured.*—The status of the large volume high pressure gas measuring art is such that there is no longer any excuse for not using large volume meters where needed. The gas should be measured in the field, not at individual wells but in groups of wells, so as to get a definite basis as to the amount of gas that is put into the line.

All gas removed from the transmission line into lateral lines or town distributing plants should also be measured at the point of removal, so as to give a definite check on the loss in the distributing plant, as well as in the main or lateral line back to the field measurement. The annual figures obtained should be made public so that the relative efficiencies of the different lines could be noted, and all distributing plant leakage should be reported in terms of "1,000" cu. ft. of gas lost per annum per mile of 3-inch main.

(16) *Gas Leakage Must Be Curtailed.*—Considerable money must be spent in correcting the leakage conditions now prevailing, not only in the main lines but also in the distributing plants, and the hunting and locating of leaks must be regarded as a continuous task.

(17) *Wasteful Appliances Must Be Eliminated.*—The Ontario Government should issue rules that would prohibit the use of wasteful appliances in the home. Where one consumer wastes gas, even though he may pay for the waste, he at the same time destroys that which his neighbor has need of and interferes with the service to his neighbor, and the question of home waste is therefore a matter in which the community interest is paramount.[1]

(18) *Appliances Should Be Inspected.*—Arrangements should be made at once for the gas companies to have competent men inspect all natural gas using appliances, and show the consumer what changes would be necessary in order to bring about correct use of gas.[2]

(19) *Future Extensions for Maintaining Service Should Not Be Capitalized.*—Extensions in the way of additional drilling operations, field lines or remedial measurers to curtail leakage, should not be capitalized, but should be wiped out in the operating account each year. Such expenditures are merely made to maintain continuity of service and the capital account should not be increased. In cases where the extensions could not all be wiped out in one year they should be amortized within two or three years, but never charged to capital.

(20) *Pressures must be lowered.*—The distributing plant pressures carried are too high for good service. Lowering of the pressures and properly adjusted appliances will not only greatly curtail the leakage in the distributing plant, but will also improve the operating conditions in the home. That is, pressures in the neighborhood of from one to two ounces will give much better service than pressures in the neighborhood of four ounces.[3]

---

[1] For further discussion *see* Amicus Curiæ report on "Can preventable waste of natural gas in home be prohibited by rules authorized by public service commissions?" Prepared for The Public Service Commission of the Commonwealth of Pennsylvania, Harrisburg, Pa., April 2, 1921.

[2] For further discussion see Resolutions adopted by National Committee on Natural Gas Conservation, promulgated by the United States Bureau of Mines, Washington, D.C., June 11, 1920.

[3] For further discussion of low pressure see Ohio State University Bulletin No. 28, on Effect of gas pressure on natural gas cooking operations in the home.

(21) *Competition in Field Should Be Eliminated.*—The entire field should be operated as a unit, so as to carry uniform pressures as the rock pressures go down.

(22) *Industrial Gas.*—If the field is operated on a conservation basis, then industrial gas sales can be eliminated and the gas saved for the future. While the selling of industrial gas during summer time has depleted the volume available for future use, it has also kept the average domestic price down. To eliminate industrial sales and save the gas for future service must, from the very nature of the case, result in a higher domestic price.

(23) *Conservation and Price.*—I do not believe that there should be a rate increase without proper provision for conservation of the residue supplies. I also know, as a positive fact, that there can be no conservation of residue supplies without an adequate price. The development necessary to get the residue supplies cannot be coerced, but must be induced by an adequate compensatory rate.

Even if every commodity price goes down in the next five years natural gas prices must go up, not because of any economic law of supply and demand, but because only adequate prices will keep the industry functioning for the future, and without such functioning in making natural gas worth saving, natural gas consumers must very shortly in the larger towns go back to manufactured gas, which will have a cost equivalent of at least $2.50 for natural gas, and the smaller towns will be without any gas at all, because manufactured gas plants cannot be maintained in small towns.

Everything that should be done to distribute and use natural gas as it ought to be used must be done to use manufactured gas at all, and if this is done at once, by both the gas companies and the public, no manufactured gas need be used for many years. The magnitude of the retail price will, therefore, determine the degree of conservation that is expedient or possible.

(24) *Determination of Fair Price for Natural Gas.*—This requires the determination of the following four factors:

A—Present fair value of property used and useful in rendering public utility service. The representatives of the companies and the public ought to be able to agree on this figure without going to the expense of any more appraisal work, which, in my judgment, is entirely unnecessary.

B—Operating cost, including taxes and extensions necessary to maintain service.

C—Rate of return on fair present value. This must provide for:

a—Expenditures made or liabilities accrued in the form of a sinking fund, or replacements to maintain the integrity of the property value.

b—Legal rate of interest. Money has just as definite and tangible a cost as a piece of pipe, and this must be ultimately reckoned with—although frequently ignored in all business enterprises.

c—Profit commensurate with the hazard of the enterprise. There is no profit in the enterprise until the above three factors have been provided for, notwithstanding the fact that normal interest rate is frequently confused with profit. The interest for the use of the money included in "b" above is merely the money paid for the use of capital, while profits have their source in the business ability, skill and foresight of the management—as well as in the risks assumed—and are entirely separate and distinct from, and in addition to the amount of money paid for the use of capital.

D—Volume of gas that can be sold through ultimate consumers' meters in the future.

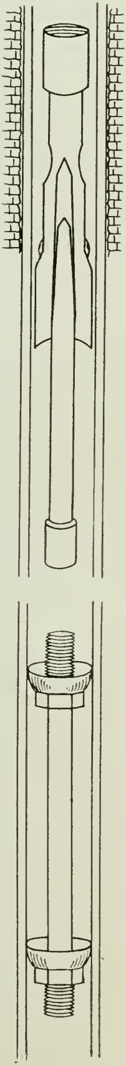
The foregoing operating cost "B" plus the product of the rate of return into the fair value of the property will give the total income needed. This total income divided by item "D" will give the average fair price of gas per "M" to the ultimate consumer.

A New Bailing Machine

The bailing machine shown in the photograph has been designed for removing water from wells that have no tubing and can no longer be cleared of water by "blowing" (that is, shutting in the well until the pressure has increased sufficiently to carry the water out with the gas when the head of the well has been opened up). This practice of "blowing" wells is a vicious waste of gas, and has been forbidden by regulation under the Natural Gas Conservation Act, 1921.

A.—Bailing Machine.

Photograph and information through the kindness of Mr. Chas. Beam of the Dominion Natural Gas Company, Dunnville.



B.—Diagram showing tubing holder (top) which screws into packer (bottom) for renewing leaky tubing in low pressure gas wells.

B.

However, a gas well that has so little pressure left that it will not clear itself of water is of very little value, and probably not worth the cost of installing and operating a pump. The bailing machine will keep it "alive" for perhaps several years after it would otherwise have been plugged.

The machine consists of a gasoline engine and a winding drum mounted on an ordinary steel wagon frame. The mast is made of two lengths of casing that telescope inside one another. It is pivoted about one-third of the way up and can be lowered to rest in a seat at the front of the machine. This machine will raise a 4-inch bailer 22 feet long at the rate of 340 feet per minute with the engine running at a moderate speed. A 2-inch bailer in 3-inch casing or tubing can be used, and no doubt a bailer can be run in 2-inch tubing. This machine can also be used to pull ¾-inch pipe or a pump. It should be of special interest to owners of "private" wells.

Another very useful invention is credited to Ernest Lindsay of the Dominion Natural Gas Company. It is designed for use in the sort of well described, but its use is for renewing tubing. *See* diagram "B," page 35.

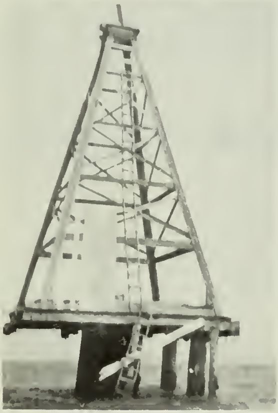
When the tubing above the packer is surrounded by water and has developed a leak near the top, heretofore it has been necessary for the tubing to be pulled out and renewed, but in the meantime enough water would have run in to the gas "sand" to require pumping or syphoning for several days, and in fact many wells if once flooded cannot be recovered. The use of this tool allows the damaged portion of the tubing to be taken out and renewed. without disturbing the packer, the tool being removed without allowing any water to reach the gas "sand."

Mr. Lindsay describes the method used as follows:—

Taking a particular case where the tubing is leaking 60 feet below the top of the casing head, 70 or 80 feet of the ¾-inch syphon pipe is pulled out and the plunger with the leather cup screwed into the ¾-inch pipe. On top of this is screwed the tool shown in the cut which holds the tubing from turning. On top of this again is screwed enough inch pipe to allow the ¾-inch pipe to rest on the bottom. The weight of the inch pipe forces the tapered part of the holder into the lower split portion or jaws made of steel, causing it to expand, the corners engaging the inside of the tubing and holding it fast. A wrench is put on the one-inch pipe at the surface to hold the tubing steady and another wrench is used for unscrewing the tubing in the usual way. It practically always comes apart at the joint immediately above where it is held. The faulty tubing is replaced by sound tubing and put back in the well in the usual way.

Gas Wells in Lake Erie

The photo shows one of the wells drilled in Lake Erie, off shore and opposite Port Alma. Storms break over the floor of the derrick, and ice batters and shoves against this slim column in winter. There is no doubt that the action of ice has diverted the column from the perpendicular, as the piling has been torn away on the shore side. One well head at least in Lake Erie has been entirely swept away through the action of ice, and in such a case the lake water flows freely down into the well, floods the gas sand and ultimately ruins the gas field. Wells drilled in Lake Erie should have more protection than is shown in this photograph.



One of the gas wells in Lake Erie near Port Alma, Tilbury East. An attempt to reach the rickety ladder from a row-boat impresses one with the difficulty and danger of well-drilling in Lake Erie. Note the destruction of piling by an ice shove.

General

An attempt is being made to keep abreast with all developments of the natural gas industry, from the gas wells to the burners. Catalogues are received in the Commissioner's office from all makers of drilling equipment as they are published. A complete set of pamphlets issued by the United States Bureau of Mines on latest methods of field work and treatment of troubles met with in various phases of the industry, as well as many professional papers on the geology of the various States, may be consulted by those interested, also data on the use of the rotary core barrel bit and the development of the diamond drill for use in oil and gas fields.

A study has been made of the latest uses of fuels for manufacturing, and the progress made in utilizing our growing resources of electricity for heating metals and ovens. Catalogues and literature are on hand for reference.

Such records as can be had from drill cuttings taken from gas and oil wells are carefully tabulated, in the hope that they will assist in interpreting the stratigraphy of that part of the Province in which the sedimentary rocks occur.

Locating Gas Leak with Match

The photo shows what remains of a house where a lighted match was used to find a leak in the gas fixtures. The house was filled with gas when the match was lighted.

The result of searching for a gas leak with a match or lamp. Note that only the brick basement of the building remains.

Drillers' Logs

The following logs of wells drilled in 1921 are published as given by the drillers. It will be noted that different drillers use different nomenclature, which is apt to be confusing, but it is hoped that during the year 1922 logs will be collected and shown in the form of cross-sections through the Province, in which form they will be much easier to visualise.

Log No 1; Information by John Stroup, Merlin

Lot.	Concession.	Township	County
11	Middle Road South	Tilbury East	Kent

Estimated production: 70,000.

Completed: Oct. 29th, 1921.

Formation.	Thickness of Formation	Total Depth
Drift Clay	147 Feet	147 Feet
Soap	15 "	162 "
Upper Lime	18 "	180 "
Soap	45 "	225 "
Shell	4 "	229 "
Lime	207 "	436 "
Sharp Sand	140 "	576 "
Lime	678 "	1,254 "
Brown Lime	109 "	1,363 "
Total Depth	1,363 ft.	

Log No. 2; Information by A. E. Randall, Petrolia.

Lot.	Concession.	Township.	County.
1	1	Raleigh	Kent.

Estimated Production: (oil) Dry Hole. Completed May 30th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	81 Feet	81 Feet
Soap	28 "	109 "
Lime	4 "	113 "
Soap	25 "	138 "
Lime	8 "	146 "
Soap	2 "	148 "
Lime	7 "	155 "
Soap	31 "	186 "
Big Lime	146 "	332 "
Total Depth	332 Feet.	

Log No. 3; Information by A. E. Randall, Petrolia.

Lot.	Concession.	Township.	County.
1	1	Raleigh.	Kent.

Estimated Production: (oil) Dry Hole. Completed June 18th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	85 Feet.	85 Feet
Sand	10 "	95 "
Soap	20 "	115 "
Lime	4 "	119 "
Soap	21 "	140 "
Lime	8 "	148 "
Soap	2 "	150 "
Lime	10 "	160 "
Soap	31 "	191 "
Big Lime	103 "	294 "
Total Depth	294 Feet.	

Log No. 4; Information by A. Humber, Ruthven.

Lot.	Concession.	Township.	County.
1	1	Raleigh	Kent.

Estimated Production: (oil) 8 bbls. Completed: June 25th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	85 Feet	85 Feet
Soap	56 "	141 "
Lime	8 "	149 "
Soap	31½"	180½"
Big Lime	78½"	259 "
Total Depth	259 Feet.	Oil at 250. Feet.

Log No. 5; Information by A. Humber, Ruthven.

Lot.	Concession.	Township.	County.
1	1	Raleigh	Kent.

Estimated production: (oil) Dry Hole. Completed: July 27th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	82 Feet	82 Feet
Soap	27 “	109 “
Shale	2 “	111 “
Soap	21 “	132 “
Shale	23 “	155 “
Soap	27 “	182 “
Shale	3 “	185 “
Big Lime	75 “	260 “
Total Depth	260 Feet.	

Log No. 6; Information by E. Wolfe, Woodslea.

Lot.	Concession.	Township.	County.
1	1	Raleigh.	Kent.

Estimated production: (oil) Pumped 50 bbls. first 48 hrs. Completed July 27th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	75 Feet	75 Feet
Sand	10 “	85 “
Soap	16 “	101 “
Lime	2 “	103 “
Soap	38 “	141 “
Lime	4 “	145 “
Soap	31½“	176½“
Big Lime	101½ “	278 “
Total Depth	278 Feet.	Oil at 209 Feet. Oil at 245 Feet.

Log No. 7; Information by E. Wolfe. Woodlea.

Lot.	Concession.	Township.	County.
1	1	Raleigh.	Kent.

Estimated production: (oil) Pumped 10 bbls. in 12 hrs. Completed June 28th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	81 Feet	81 Feet
Sand	10 “	91 “
Soap	47 “	138 “
Lime	10 “	148 “
Soap	31 “	179 “
Big Lime	107 “	286 “
Total Depth	286 Feet.	Oil at 148 Feet. Oil at 250 Feet.

Log No. 8; Information by E. Wolfe, Woodslea.

Lot.	Concession.	Township.	County.
1	1	Raleigh.	Kent.

Estimated production: (oil) Pumped 5 bbls. in 12 hrs. Completed July 21st, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	81 Feet	81 Feet
Soap	19 "	100 "
Shale	2½ "	102½"
Soap	2 "	104½"
Shale	½"	105 "
Soap	27 "	132 "
Lime	13 "	145 "
Soap	31 "	176 "
Big Lime	115 "	291 "
Total Depth	291 Feet.	

Oil at 145 Feet.
Oil at 177½ Feet.
Oil at 246 Feet.

Log No. 9; Information by Union Nat. Gas Co., Chatham.

Lot.	Concession.	Township.	County.
10	11	Tilbury East	Kent.

Estimated production: 124,700 cu. ft. Completed Oct. 5th, 1921

Formation.	Thickness of Formation.	Total Depth.
Surface	155 Feet	155 Feet
Soap	61 "	216 "
Lime	274 "	590 "
Sharp Sand	210 "	700 "
Lime	410 "	1,110 "
Gas Sand	298 "	1,408 "
Total Depth	1,408 Feet.	

Gas at 1,340 Feet.
Gas at 1,376 Feet.
Water at 375 Feet.
Water at 700 Feet.

Log No. 10; Information by Union Nat. Gas Co., Chatham

Lot.	Concession.	Township.	County.
11	11	Tilbury East	Kent.

Estimated production: 284,000 cu. ft. Completed Sept. 4th, 1921

Formation.	Thickness of Formation.	Total Depth.
Surface	150 Feet	150 Feet
Soap	45 "	195 "
Lime	305 "	500 "
Sharp sand	220 "	720 "
Brown lime	30 "	750 "
Lime	425 "	1,175 "
Gas sand	218 "	1,393 "
Total Depth	1,393 Feet.	

Water at 350 and 700 feet. Gas at 1,211, 1,330, 1,350 and 1,375 feet

LOG NO. 11; INFORMATION BY UNION NATURAL GAS CO., CHATHAM.

Lot.	Concession.	Township.	County.
13	14	Tilbury East	Kent.

Estimated production: 284,000 cu. ft. Completed Aug. 3rd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	162 Feet.	162 Feet
Soap	14 “	176 “
Lime	1,004 “	1,180 “
Gas Sand	201 “	1,381 “
Total Depth	1,381 Feet.	

Gas at 1,200 and 1,250 feet. Water at 625 feet.

LOG NO. 12; INFORMATION BY UNION NATURAL GAS CO., CHATHAM.

Lot.	Concession.	Township.	County.
12	Middle Road South.	Tilbury East.	Kent.

Estimated production: open flow very light, well abandoned. Completed Dec. 10th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	155 Feet	155 Feet
Soap	43 “	198 “
Lime	282 “	480 “
Sharp Sand	220 “	700 “
Lime	530 “	1,230 “
Gas Sand	150 “	1.380 “
Total Depth	1,380 Feet	

Gas at 1,325 and 1,377 feet. Water at 465 and 1,330 feet.

LOG NO. 13; INFORMATION BY UNION NATURAL GAS CO., CHATHAM.

Lot.	Concession.	Township.	County.
12	Middle Road South	Tilbury East	Kent.

Estimated production: 373,100 cu. feet. Completed July 29th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	147 Feet	147 Feet
Soap	45 “	192 “
Lime	298 “	490 “
Sharp Sand	190 “	680 “
Lime	500 “	1,180 “
Gas Sand	163 “	1,343 “
Total Depth	1,343 Feet.	

Gas at 1,185, 1,285 and 1,310 feet. Water at 335 and 670 feet.

Log No. 14; Information by Union Natural Gas Co., Chatham.

Lot.	Concession.	Township.	County.
12	Middle Road South.	Tilbury East	Kent.

Estimated production: 781,000 cu. ft.
Rock pressure: 293 lbs.

Completed June 10th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	145 Feet	145 Feet
Soap	40 "	185 "
Lime	340 "	555 "
Sharp Sand	190 "	745 "
Lime	465 "	1,180 "
Gas Sand	161 "	1,341 "
Total Depth	1,341 Feet.	

Gas at 1,180 and 1,305 feet.

Water at 330 feet.

Log No. 15; Information by Union Natural Gas Co., Chatham.

Lot.	Concession.	Township.	County.
12	Middle Road South.	Tilbury East	Kent.

Estimated production: 1,840,000 cu. ft.
Rock pressure: 310 lbs.

Completed April 22nd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	145 Feet	145 Feet
Soap	40 "	185 "
Lime	205 "	390 "
Sharp Sand	160 "	550 "
Lime	490 "	1,140 "
Gas Sand	206 "	1,346 "
Total Depth	1,346 Feet.	

Gas at 1,160 and 1,265 feet.

Water at 145 feet

Log No. 16; Information by Union Natural Gas Co., Chatham.

Lot.	Concession.	Township.	County.
10	10	Tilbury East.	Kent.

Estimated production: 325,000 cu. ft.
Rock pressure: 310 lbs.

Completed Nov. 23rd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	151 Feet	151 Feet
Soap	38 "	189 "
Lime	281 "	470 "
Sharp Sand	670 "	1,140 "
Gas Sand	249 "	1,389 "
Total Depth	1,389 Feet.	

Gas at 1,200, 1,290 and 1,330 feet.

Water at 678 feet

Log No. 17; Information by John Stroup, Merlin.

Lot.	Concession.	Township.	County.
13	Middle Road South.	Tilbury East.	Kent.

Estimated production: 1,000,000 cu. ft. Completed June 9th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	130 Feet	130 Feet
Shale	17 "	147 Feet
Soap	18 "	165 "
Gray Lime	865 "	1,030 "
Lime and Slate	145 "	1,175 "
Gray Lime	143 "	1,318 "
Total Depth	1,318 Feet.	

Log No. 18; Information by John Stroup, Merlin.

Lot.	Concession.	Township.	County.
13	12	Tilbury East.	Kent.

Estimated production: 85,000 cu. ft. Completed Sept. 12th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Drift Clay	145 Feet	145 Feet
Soap	40 "	185 "
Big Lime	140 "	325 "
Dark Lime	250 "	575 "
Sharp Sand	65 "	640 "
Lime	744 "	1384 "
Total Depth	1,384 Feet.	

Log No. 19; Information by E. P. Rowe, Toronto.

Lot.	Concession.	Township.	County.
1	1	Dover.	Kent.

Estimated production: 80,000. Completed May, 1921.
Rock pressure: 900 lbs.

Formation.	Thickness of Formation.	Total Depth.
Surface	97 Feet	97 Feet
Shale Top Rock	6 "	103 "
Upper Soap Hamilton	115 "	218 "
Middle Lime	15 "	233 "
Lower Soap	68 "	301 "
Onondaga	1,290 "	1,591 "
Niagara	350 "	1,941 "
Niagara Shale, Dark	51 "	1,992 "
Red Shale	50 "	2,042 "
Grey Shale	30 "	2,072 "
Clinton Lime and Dolomite	70 "	2,142 "
Red Shale, Medina	60 "	2,202 "
White Medina	20 "	2,222 "
Red Medina	280 "	2,502 "
Hudson River	291 "	2,793 "
Utica, brown and black	114 "	2,907 "
Trenton	398 "	3,305 "
Total Depth	3,305 Feet.	

Gas at 2,927, 3,025, 3,075 and 3,105 feet. Small show of oil.

Log No. 20; Information by W. J. Hussey, Petrolia.

Lot.	Concession.	Township.	County.
4 J. A. Ferguson farm.	2	Raleigh.	Kent.

Dry Hole.

Formation.	Thickness of Formation.	Total Depth.
Surface	70 Feet	70 Feet
Gravel	15 "	85 "
Shale	50 "	135 "
Top Soap	95 "	230 "
Middle Lime	18 "	248 "
Lower Soap	52 "	300 "
Lower Lime	200 "	500 "
Total Depth	500 Feet.	

Log No. 21; Information by W. J. Hussey, Petrolia.

Lot.	Concession.	Township.	County.
4	2	Raleigh.	Kent.

Dry Hole.

Formation.	Thickness of Formation.	Total Depth.
Surface	51 Feet	51 Feet
Gravel and Sand	15 "	66 "
Top Rock	30 "	96 "
Top Soap	130 "	226 "
Middle Lime	12 "	238 "
Lower Soap	24 "	262 "
Lower Lime	138 "	400 "
Total Depth	400 Feet.	

Log No. 22; Information by Stover Drilling Co., Chatham.

Lot.	Concession.	Township.	County.
11	4	Dover E.	Kent.

Open flow: 10,000 cu. ft.
Oil: 5 bbls. per day.

Completed Dec. 9th, 1920.

Formation.	Thickness of Formation.	Total Depth.
Surface	75 Feet	75 Feet
Black Shale	28 "	103 "
Soapstone and Limestone	200 "	303 "
Corniferous Limestone	102 "	405 "
Sylvania Limestone	70 "	475 "
Onondaga Limestone and Dolomite	885 "	1,360 "
Onondaga Limestone and Rock Salt	110 "	1,470 "
Guelph Dolomite	215 "	1,685 "
Niagara Limestone	267 "	1,952 "
Niagara Shale	15 "	1,967 "
Clinton Sandstone	25 "	1,992 "
Red Shale	58 "	2,050 "
Grey Shale	80 "	2,130 "
White Medina	5 "	2,135 "
Red Medina Shale	105 "	2,240 "
Hudson River Limestone and Shale	485 "	2,725 "
Utica Shale	173 "	2,898 "
Trenton Limestone	434 "	3,332 "
Total Depth	3,332 Feet.	

LOG NO. 23; INFORMATION BY JOHN STROUP, MERLIN.

Lot.	Concession.	Township.	County.
11	Middle Road South.	Tilbury E.	Kent.

Open flow: 120,000 cu. ft.
Rock pressure: 290 lbs.

Completed Dec. 14th, 1921.

Formation.	Thickness of Formation.	Total Depth
Clay	128 Feet	128 Feet
Quick Sand	17 "	145 "
Shale	5 "	150 "
Soap	22 "	172 "
Lime	38 "	210 "
Lime	230 "	440 "
Sharp Sand	80 "	520 "
Lime	834 "	1,354 "
Total Depth	1,354 Feet	

LOG NO. 24; INFORMATION BY AJAX OIL AND GAS CO., TORONTO.

Lot.	Concession.	Township.	County.
2	1	Raleigh.	Kent.

Completed January, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	60 Feet	60 Feet
Quick Sand	42 "	102 "
Soap	14 "	116 "
Hard Lime	8 "	124 "
Soft Soap	18 "	142 "
Soft Lime	8 "	150 "
Hard Lime	15 "	165 "
Soap	27 "	192 "
Hard Lime	88 "	280 "
Soft Lime	18 "	298 "
Total Depth	298 Feet.	

Oil at 210, 235, 265 and 280 feet.

LOG NO. 25; INFORMATION BY GEO. D. BROWN, CHATHAM.

Lot.	Concession.	Township.	County.
2	2 & 3	Raleigh.	Kent.

Completed Feb. 19th, 1921.

Formation	Thickness of Formation.	Total Depth.
Clay	65 Feet	65 Feet
Sand	36 "	101 "
Soap	27 "	128 "
Middle Lime	7 "	135 "
Soap	35 "	170 "
Lower Soap	35 "	205 "
Lower Lime	95 "	300 "
Total Depth	300 Feet.	

Oil at 130 feet.

Gas at 208 feet.

Log No. 26; Information by Geo. D. Brown, Chatham.

Lot.	Concession.	Township.	County.
2	2 and 3	Raleigh	Kent.

Completed March 22nd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	70 Feet	70 Feet
Sand	31 "	101 "
Soap	19 "	120 "
Lime	7 "	127 "
Soap	13 "	140 "
Lime	1 "	141 "
Soap	6 "	147 "
Lime	13 "	160 "
Soap	34 "	194 "
Limestone	109 "	303 "
Total Depth	303 Feet.	

Oil at 232 feet. Gas at 275 feet

Log No. 27; Information by A. E. Randall, Petrolia.

Lot.	Concession.	Township.	County.
2	2 and 3	Raleigh.	Kent.

Completed Dec. 3rd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Subsoil	10 Feet	10 Feet
Clay	24 "	34 "
Sand and Gravel	4 "	38 "
Clay	32 "	70 "
Sandy Clay	22 "	92 "
Soap	15 "	107 "
Lime	4 "	111 "
Soap	1 "	112 "
Lime	2 "	114 "
Soap	26 "	140 "
Lime	5 "	145 "
Soap	5 "	150 "
Middle Lime	6 "	156 "
Lower Lime	29 "	185 "
Lower Lime	105 "	290 "
Total Depth	290 "	

Oil at 190 feet.

Log No. 28; Information by A. E. Randall, Petrolia.

Lot.	Concession.	Township.	County.
2	2 and 3.	Raleigh.	Kent.

Completed Dec. 28th, 1922.

Formation.	Thickness of Formation.	Total Depth.
Subsoil	8 Feet	8 Feet
Clay	47 "	55 "
Sandy Clay	15 "	70 "
Soap and Clay	10 "	80 "
Sand	15 "	95 "
Soap	33 "	128 "
Lime	2 "	130 "
Soap	2 "	132 "
Lime	2 "	134 "
Soap	27 "	161 "
Middle Lime	5 "	166 "
Soap	5 "	171 "
Lime	2 "	173 "
Soap	37 "	210 "
Lower Lime	90 "	300 "
Total Depth	300 Feet.	

Oil at 216 feet. Gas at 262 Feet

Log No. 29; Information by Bon Jasperson, Kingsville.

Lot.	Concession.	Township.	County.
8	1	Gosfield S.	Essex.

Open flow: 17,000 cu. ft.
Rock pressure: 240 lbs.

Completed Nov. 28th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Quick Sand	85 Feet	85 Feet
Grey Lime	416 "	501 "
Brown Lime	189 "	690 "
Grey Lime	60 "	750 "
Slate	90 "	840 "
Lime	60 "	900 "
Lime	130 "	1,030 "

Total Depth . . . . 1,030 Feet.

Log No. 30; Information by Imperial Oil Co.

Lot.	Concession.	Township.	County.
1	1	Mersea.	Essex.

Dry Hole.

Completed February, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	121 Feet	121 Feet
Limestone	744 "	865 "
Limestone	770 "	1,635 "
Red Shale	20 "	1,655 "
Grey Shale	18 "	1,673 "
Red Shale	13 "	1,686 "
Grey Shale	80 "	1,766 "
Grey Lime	26 "	1,792 "
Red Shale	112 "	1,904 "
Grey Shale	52 "	1,956 "
Red Shale	40 "	1,996 "
Grey Shale	480 "	2,476 "
Black and Grey Shale	35 "	2,511 "
Trenton Lime	825 "	3,336 "
Sandstone	10 "	3,346 "

Total Depth . . . . 3,346 Feet.

Log No. 31; Information by Glenwood Company.

Lot.	Concession.	Township.	County.
18	4	Mersea.	Essex.

Open flow: 22,000 cu. ft.
Rock pressure: 300 lbs.

Completed Aug. 5th, 1921

Formation.	Thickness of Formation.	Total Depth.
Clay	75 Feet.	75 Feet
Gray Lime	205 "	280 "
Brown Lime	200 "	480 "
Lime	195 "	675 "
Brown Lime	125 "	800 "
Lime	190 "	990 "
Salt Sand	17 "	1,007 "

Total Depth . . . . 1,007 Feet.
Salt water at 990 feet.

Log No. 32; Information by Union Exploration Co., Chatham.

Lot.	Concession.	Township.	County.
24	5	Dawn No. 3.	Lambton.

Open flow: 177,400 cu. ft.
Rock pressure: 775 lbs.

Completed November, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	90 Feet	90 Feet
Shale	190 "	280 "
Soap	180 "	460 "
Lime	65 "	525 "
Soap	15 "	540 "
Grey Lime	1,075 "	1,615 "
Clinton	535 "	2,150 "
Total Depth	2,150 Feet.	

Gas at 1,615 and 1,750 feet.

Water at 610 feet

Log No. 33; Information by John Kenney, Dunnville.

Lot.	Concession.	Township.	County.
4	7	Crowland.	Welland.

Open flow: 150,000 cu. ft.
Rock pressure: 200 lbs.

Completed Nov. 3rd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Niagara Dolomite	78 Feet	78 Feet
Limestone and Shale	400 "	478 "
Clinton Shale	55 "	533 "
Clinton Lime	37 "	570 "
Red Medina	60 "	630 "
Blye Shale	40 "	670 "
White Medina	15 "	685 "
Red Shale	23 "	708 "
Total Depth	708 Feet.	

Gas at 538, 570-630 and 680 feet.

Water at 450 feet

Log No. 34; Information by John Kenney, Dunnville.

Lot.	Concession.	Township.	County.
3	7	Crowland	Welland.

Open flow: 20,000 cu. ft.
Rock pressure: 250 lbs.

Completed Aug. 24th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	100 Feet	100 Feet
Shale	100 "	200 "
Niagara Dolomite	260 "	460 "
Clinton Shale	50 "	510 "
Clinton Lime	32 "	542 "
Red Medina	58 "	600 "
Blue Shale	30 "	630 "
White Medina	15 "	645 "
Red Shale	41 "	686 "
Total Depth	686 Feet.	

Water at 150. Black water at 210 with sulphur gas.

LOG NO. 35; INFORMATION BY C. W. FEATHERSTONE, DUNNVILLE.

Lot.	Concession.	Township.	County.
10	14	Walpole	Haldimand.

Open flow: 150,000 cu. ft. Completed July 26th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	10 Feet	10 Feet
Flint	50 "	60 "
Lime and Shale	365 "	425 "
Niagara	274 "	699 "
Casing Shale	21 "	720 "
Clinton	33 "	753 "
Red Medina	20 "	773 "
Grey Shale	66 "	839 "
White Medina	12 "	851 "
Red Shale	13 "	864 "
Total Depth	864 Feet.	

LOG NO. 36; INFORMATION BY C. W. FEATHERSOTNE, DUNNVILLE.

Lot.	Concession.	Township.	County.
11	13	Walpole.	Haldimand.

Open flow: 100,000 cu. ft. Completed May 9th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	17 Feet	17 Feet
Lime and Shale	413 "	430 "
Niagara	200 "	630 "
White Lime	70 "	700 "
Shale	26 "	726 "
Clinton	37 "	763 "
Red Medina	24 "	787 "
Gray Shale	56 "	843 "
White Medina	12 "	855 "
Red Shale	5 "	860 "
Total Depth	860 Feet.	

LOG NO. 37; INFORMATION BY C. W. FEATHERSTONE, DUNNVILLE.

Lot.	Concession.	Township.	County.
Part of Young Tract.		Seneca.	Haldimand.

Open flow: 103,000 cu. ft. Completed Aug. 24th, 1921
Rock pressure: 230 lbs.

Formation.	Thickness of Formation.	Total Depth.
Surface	95 Feet	95 Feet
Lime and Shale	100 "	195 "
Niagara	250 "	445 "
Shale	44 "	489 "
Clinton	29 "	518 "
Red Medina	37 "	555 "
Blue Shale	60 "	615 "
White Medina	15 "	630 "
Red Shale	50 "	680 "
Total Depth	680 Feet.	

Gas at 494 and 513 feet.

LOG NO. 38; INFORMATION BY C. W. FEATHERSTONE, DUNNVILLE.

Lot.	Concession.	Township.	County.
Part of Dennis Block.	–	Oneida.	Haldimand.

Open flow: 58,000 cu. ft.
Rock pressure: 270 lbs.

Completed Sept. 2nd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	44 Feet	44 Feet
Lime and Shale	150 "	194 "
Niagara	250 "	444 "
Shale	16 "	460 "
Clinton	24 "	484 "
Red Medina	34 "	518 "
Blue Shale	63 "	581 "
White Medina	11 "	592 "
Red Shale	51 "	643 "
Total Depth	643 Feet.	

Gas at 465 and 472 feet.

LOG NO. 39; INFORMATION BY C. W. FEATHERSTONE, DUNNVILLE.

Lot.	Concession.	Township.	County.
Part of Dennis Block.		Oneida.	Haldimand.

Open flow: 18,000 cu. ft.
Rock pressure: 260 lbs.

Completed Oct. 13th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	46 Feet	46 Feet
Lime and Shale	214 "	260 "
Niagara	259 "	519 "
Shale	22 "	541 "
Clinton	21 "	562 "
Red Medina	37 "	599 "
Blue Shale	53 "	652 "
White Medina	11 "	663 "
Red Shale	50 "	713 "
Total Depth	713 Feet.	

Gas at 543 and 553 feet.

LOG NO. 40; INFORMATION BY C. W. FEATHERSTONE, DUNNVILLE.

Lot.	Concession.	Township.	County.
Farm of Wm. Bell		Oneida.	Haldimand.

Open flow: 37,000 cu. ft.
Rock pressure: 270 lbs.

Completed Nov. 3rd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	28 Feet	28 Feet
Lime and Shale	197 "	225 "
Niagara	243 "	468 "
Shale	28 "	496 "
Clinton	26 "	522 "
Red Medina	39 "	561 "
Blue Shale	63 "	624 "
White Medina	12 "	636 "
Red Shale	54 "	690 "
Total Depth	690 Feet.	

Log No. 41; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
72 and 73.	River Range.	Oneida.	Haldimand.

Open flow: 111,000 cu. ft.
Rock pressure: 240 lbs.

Completed Nov. 29th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	24 Feet	24 Feet
Lime and Shale	196 "	220 "
Niagara	242 "	462 "
Shale	36 "	498 "
Clinton	22 "	520 "
Red Medina	45 "	565 "
Blue Shale	52 "	617 "
White Medina	12 "	629 "
Red Shale	39 "	668 "
Total Depth	668 Feet.	

Gas at 522-540 feet.

Log No. 42; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
64	River Range.	Oneida.	Haldimand.

Open flow: 88,000 cu. ft.
Rock pressure: 310 lbs.

Completed May 17th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	56 Feet	56 Feet
Lime and Shale	179 "	235 "
Niagara	233 "	468 "
Shale	34 "	502 "
Clinton	29 "	531 "
Red Medina	45 "	576 "
Blue Shale	59 "	635 "
White Medina	10 "	645 "
Red Shale	50 "	695 "
Total Depth	695 Feet.	

Gas at 510, 530, 541 and 640 feet.

Log No. 43; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
Part of Young Tract.		Seneca.	Haldimand.

Open flow: 58,000 cu. ft.
Rock pressure: 280 lbs.

Completed May 30th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	84 Feet	84 Feet
Lime and Shale	141 "	225 "
Niagara	245 "	470 "
Shale	40 "	510 "
Clinton	25 "	535 "
Red Medina	33 "	568 "
Blue Shale	55 "	623 "
White Medina	25 "	648 "
Red Shale	51 "	699 "
Total Depth	699 Feet.	

Gas at 512 and 569 feet.

Log No. 44; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
62	River Range.	Oneida.	Haldimand.

Open flow: 105,000 cu. ft.
Rock pressure: 345 lbs.

Completed June 9th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	48 Feet	48 Feet
Lime and Shale	172 "	220 "
Niagara	254 "	474 "
Shale	32 "	506 "
Clinton	28 "	534 "
Red Medina	30 "	564 "
Blue Shale	56 "	620 "
White Medina	10 "	630 "
Red Shale	50 "	680 "
Total Depth	680 Feet.	

Gas at 508, 516, 531, 549 and 625.

Log No. 45; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
Part of Young Tract.		Seneca.	Haldimand.

Open flow: 68,000 cu. ft.
Rock pressure: 260 lbs.

Completed June 21st, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	104 Feet	104 Feet
Lime and Shale	114 "	218 "
Niagara	245 "	463 "
Shale	32 "	495 "
Clinton	33 "	528 "
Red Medina	38 "	566 "
Blue Shale	50 "	616 "
White Medina	15 "	631 "
Red Shale	46 "	677 "
Total Depth	677 Feet.	

Gas at 499 and 530 feet.

Log No. 46; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
60	River Range.	Oneida.	Haldimand.

Open flow: 97,000 cu. ft.
Rock pressure: 305 lbs.

Completed July 2nd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	57 Feet	57 Feet
Lime and Shale	171 "	228 "
Niagara	254 "	482 "
Shale	19 "	501 "
Clinton	22 "	523 "
Red Medina	40 "	563 "
Blue Shale	63 "	626 "
White Medina	11 "	637 "
Red Shale	50 "	687 "
Total Depth	687 Feet.	

Gas at 503, 511, 628 and 636 feet.

LOG NO. 47; INFORMATION BY C. W. FEATHERSTONE, DUNNVILLE.

Lot.	Concession.	Township.	County.
Part of Young Tract.		Seneca.	Haldimand.

Open flow: 37,000 cu. ft.
Rock pressure: 260 lbs.

Completed July 15th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	96 Feet	96 Feet
Lime and Shale	119 “	215 “
Niagara	245 “	460 “
Shale	34 “	494 “
Clinton	30 “	524 “
Red Medina	35 “	559 “
Blue Shale	60 “	619 “
White Medina	21 “	640 “
Red Shale	50 “	690 “

Total Depth................ 690 Feet.
Gas at 499, 519 and 629 feet.

LOG NO. 48; INFORMATION BY C. W. FEATHERSTONE, DUNNVILLE.

Lot.	Concession.	Township.	County.
Farm of C. H. Wills.		Seneca.	Haldimand.

Open flow: 100,000 cu. ft.
Rock Pressure: 230 lbs.

Completed Aug. 10th, 1921

Formation.	Thickness of Formation.	Total Depth.
Surface	102 Feet	102 Feet
Lime and Shale	113 “	215 “
Niagara	245 “	460 “
Shale	39 “	499 “
Clinton	28 “	527 “
Red Medina	35 “	562 “
Blue Shale	55 “	617 “
White Medina	12 “	629 “
Red Shale	50 “	679 “

Total Depth................ 679 Feet.
Gas at 504, 516 and 622 feet.

LOG NO. 49; INFORMATION BY C. W. FEATHERSTONE, DUNNVILLE.

Lot.	Concession.	Township.	County.
59	River Range.	Oneida.	Haldimand.

Open flow: 88,000 cu. ft.
Rock pressure: 270 lbs.

Completed Aug. 11th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	45 Feet	45 Feet
Lime and Shale	150 “	195 “
Niagara Shale	244 “	439 “
Shale	20 “	459 “
Clinton	24 “	483 “
Red Medina	34 “	517 “
Blue Shale	63 “	580 “
White Medina	10 “	590 “
Red Shale	50 “	640 “

Total Depth................ 640 Feet.
Gas at 467, 477 and 582.

Log No. 50; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
14	River Range.	Seneca.	Haldimand.

Open flow: 55,000 cu. ft.
Rock pressure: 230 lbs.

Completed Jan. 25th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	43 Feet	43 Feet
Lime and Shale	147 “	190 “
Niagara	242 “	432 “
Shale	38 “	470 “
Clinton	27 “	497 “
Red Medina	38 “	535 “
Blue Shale	58 “	593 “
White Medina	11 “	604 “
Red Shale	50 “	654 “
Total Depth	654 Feet.	

Gas at 480, 507 and 598 feet.

Log No. 51; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
14	River Range.	Seneca.	Haldimand.

Open flow: 111,000 cu. ft.
Rock pressure: 240 lbs.

Completed Feb. 19th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	28 Feet	28 Feet
Lime and Shale	167 “	195 “
Niagara	250 “	445 “
Shale	30 “	475 “
Clinton	27 “	502 “
Red Medina	42 “	544 “
Blue Shale	61 “	605 “
White Medina	9 “	614 “
Red Shale	50 “	664 “
Total Depth	664 Feet.	

Gas at 478, 569 and 610 feet.

Log No. 52; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
“B”	Village of Indiana.	Seneca.	Haldimand.

Open flow: 55,000 cu. ft.
Rock pressure: 280 lbs.

Completed Mar. 22nd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	43 Feet	43 Feet
Lime and Shale	182 “	225 “
Niagara	246 “	471 “
Shale	32 “	503 “
Clinton	26 “	529 “
Red Medina	39 “	568 “
Blue Shale	53 “	621 “
White Medina	10 “	631 “
Red Shale	50 “	681 “
Total Depth	681 Feet.	

Gas at 507 and 522 feet.

Log No. 53; Information by C. W. Featherstone, Dunnville.

Lot.	Concession.	Township.	County.
24 and 25.	Village of Indiana.	Seneca.	Haldimand.

Open flow: 164,000 cu. ft.
Rock pressure: 260 lbs.

Completed April 13th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	50 Feet	50 Feet
Lime and Shale	172 "	222 "
Niagara	252 "	474 "
Shale	25 "	499 "
Clinton	26 "	525 "
Red Medina	42 "	567 "
Blue Shale	54 "	621 "
White Medina	10 "	631 "
Red Shale	50 "	681 "

Total Deph . . . . 681 Feet.

Gas at 504, 525 and 572 feet.

Log 54; Information by F. L. Snively, Hamilton.

Lot.	Concession.	Township.	County.
10	3	Moulton.	Haldimand.

Open flow: 70,000 cu. ft
Rock pressure: 40 lbs.

Completed June 18th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	75 Feet	75 Feet
Shale Gypsum	146 "	221 "
Niagara Lime	223 "	444 "
Shale	52 "	496 "
Clinton	25 "	521 "
Red Medina	38 "	559 "
Blue Shale	63 "	622 "
White Medina	12 "	634 "
Red Shale	50 "	684 "

Total Depth . . . . 684 Feet.

Log No. 55; Information by F. L. Snively, Hamilton.

Lot.	Concession.	Township.	County.
10	2	Moulton.	Haldimand.

Open flow: 84,000 cu. ft.
Rock pressure: 40 lbs.

Completed May 31st, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	80 Feet	80 Feet
Shale and Gypsum	139 "	219 "
Niagara Limestone	221 "	440 "
Grey Shale	55 "	495 "
Clinton	30 "	525 "
Red Medina	36 "	561 "
Blue Shale	61 "	622 "
White Medina	12 "	634 "
Red Shale	50 "	684 "

Total Depth . . . . 684 Feet.

LOG NO. 56; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
11	1	Seneca.	Haldimand.

Dry Hole. Completed Nov. 4th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	62 Feet	62 Feet
Grey Lime	110 "	172 "
Niagara Brown	110 "	282 "
Grey Shale	40 "	322 "
Clinton Grey	35 "	357 "
Red Medina	40 "	397 "
Blue Shale	55 "	452 "
White Medina	10 "	462 "
Red Shale	45 "	507 "
Total Depth	507 Feet.	

LOG NO. 57; INFORMATION BY T. J. MCCUTCHEON, DUNNVILLE.

Lot. 19	Concession.	Township.	County.
Culp Farm,	6	South Cayuga.	Haldimand.

Dry Hole. Completed April 29th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	16 Feet	16 Feet
Flint	34 "	50 "
Grey Lime	60 "	110 "
Shale and Lime	250 "	360 "
Brown Lime	70 "	430 "
Niagara Lime	175 "	605 "
Black and Grey Lime	50 "	655 "
Grey Shale	55 "	710 "
Clinton	30 "	740 "
Red Medina	40 "	780 "
Grey Shale	55 "	835 "
White Medina	12 "	847 "
Red Shale	653 "	1,500 "
Red and Grey Shale	175 "	1,675 "
Grey Shale	600 "	2,275 "
White and Black Shale	175 "	2,450 "
Trenton Limestone	703 "	3,153 "
Total Depth	3,153 Feet.	

LOG NO. 58; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
7	9	Walpole.	Haldimand.

Open flow: 21,000 cu. ft.
Rock pressure: 355 lbs. Completed March 5th, 1921

Formation.	Thickness of Formation.	Total Depth.
Surface	15 Feet	15 Feet
Flint	60 "	75 "
Grey Lime	70 "	145 "
Shale	75 "	220 "
Guelph Lime	108 "	328 "
Shale and Lime	147 "	475 "
Niagara	216 "	691 "
Shale	98 "	789 "
Clinton Sand No. 1	34 "	823 "
Red Medina Sand No. 2	37 "	860 "
Blue Shale	35 "	895 "
White Medina	22 "	917 "
Total Depth	917 Feet.	

Log No. 59; Information by F. L. Snively, Hamilton.

Lot.	Concession.	Township.	County.
7	8	Walpole.	Haldimand.

Dry hole. Completed April 16th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	17 Feet	17 Feet
Flint	45 “	62 “
White Lime	9 “	71 “
Grey Lime	78 “	149 “
Shale	66 “	215 “
Guelph Lime	115 “	330 “
Shale and Limestone	134 “	464 “
Niagara Limestone	234 “	698 “
Clinton Shale	102 “	800 “
Red Medina	36 “	836 “
Blue Shale	44 “	880 “
White Medina	15 “	895 “

Total Depth 895 Feet.

Log No. 60; Information by J. J. McLister, Dunnville.

Lot.	Concession.	Township.	County.
1	1	North Cayuga.	Haldimand.

Open flow: 42,700 cu. ft. Completed March 15th, 1921.
Rock pressure: 175 lbs.

Formation.	Thickness of Formation.	Total Depth.
Surface	45 Feet	45 Feet
Shale	135 “	180 “
Niagara	200 “	380 “
White Lime	43 “	423 “
Casing Shale	37 “	460 “
Clinton	25 “	485 “
Red Medina	40 “	525 “
Blue Shale	60 “	585 “
White Medina	15 “	600 “
Red Shale	25 “	625 “

Total Depth 625 Feet.

Log No. 61; Information by F. L. Snively, Hamilton.

Lot.	Concession.	Township.	County.
A	2	Moulton.	Haldimand.

Open flow: 6,000 cu. ft. with small show of oil.
Rock pressure: 127 lbs. Completed July 23rd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	90 Feet	90 Feet
Shale and Gypsum	110 “	200 “
Niagara	225 “	425 “
Grey Shale	51 “	476 “
Clinton	28 “	504 “
Red Medina	35 “	539 “
Blue Shale	50 “	589 “
White Medina	12 “	601 “
Red Shale	50 “	651 “

Total Depth 651 Feet.

Log No. 62; Information by F. L. Snively, Hamilton.

Lot.	Concession.	Township.	County.
65	River Range.	Oneida.	Haldimand.

Open flow: 171,000 cu. ft.
Rock pressure: 220 lbs.

Completed Jan. 6th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface Clay	25 Feet	25 Feet
Guelph Shale	194 "	219 "
Niagara	211 "	430 "
Casing Shale	17 "	447 "
Grey Shale	36 "	483 "
Clinton	22 "	505 "
Red Medina	46 "	551 "
Blue Shale	46 "	597 "
White Medina	23 "	620 "
Red Shale	50 "	670 "

Total Depth 670 Feet.
Gas at 487 and 515 Feet.

Log No. 63; Information by J. J. McLister, Dunnville.

Lot.	Concession.	Township.	County.
17	2	Canboro.	Haldimand.

Open flow: 17,000 cu. ft.
Rock pressure: 130 lbs.

Completed Dec. 5th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	46 Feet	46 Feet
Shale	120 "	166 "
Niagara	200 "	366 "
White Lime	50 "	416 "
Shale	24 "	440 "
Clinton	30 "	470 "
Red Medina	32 "	502 "
Blue Shale	60 "	562 "
White Medina	14 "	576 "
Red Shale	46 "	622 "

Total Length 622 Feet.
Gas at 490 and 578 feet.

Log No. 64; Information by J. J. McLister, Dunnville.

Lot.	Concession.	Township.	County.
17	2	Canboro.	Haldimand.

Open flow: 43,000 cu. ft.
Rock pressure: 136 lbs.

Completed Nov. 11th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	33 Feet	33 Feet
Shale	117 "	150 "
Niagara	200 "	350 "
White Lime	50 "	400 "
Shale	36 "	436 "
Clinton	28 "	464 "
Red Medina	32 "	496 "
Blue Shale	60 "	556 "
White Medina	14 "	570 "
Red Shale	51 "	621 "

Total Depth 621 Feet.
Gas at 485 and 572

Log No. 65; Information by T. J. McCutcheon, Dunnville.

Lot.	Concession.	Township.	County.
5	S.F.R.	Moulton.	Haldimand.

Open flow: 20,000 cu. ft. Completed Oct. 27th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	105 Feet	105 Feet
Lime and Shale	160 "	265 "
Niagara	225 "	490 "
Shale	50 "	540 "
Clinton Rock	30 "	570 "
Red Medina	45 "	615 "
Shale	55 "	670 "
White Medina	12 "	682 "
Red Shale	25 "	707 "

Total Depth................ 707 Feet.

Gas at 545 and 677 feet.

Log No. 66; Information by T. J. McCutcheon, Dunnville.

Lot.	Concession.	Township.	County.
6	South Forks Road.	Moulton.	Haldimand.

Open flow: 40,000 cu.ft. Completed Aug. 21st, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	76 Feet	76 Feet
Lime and shale	184 "	260 "
Niagara	220 "	480 "
Shale	50 "	530 "
Clinton Rock	30 "	560 "
Red Medina	45 "	605 "
Shale	55 "	660 "
White Medina	12 "	672 "
Red Shale	50 "	722 "

Total Depth................ 722 Feet.

Gas at 535 feet.

Log No. 67; Information by T. J. McCutcheon, Dunnville.

Lot.	Concession.	Township.	County.
6	South Forks Road.	Moulton.	Haldimand.

Open flow: 20,000 cu. ft.

Completed Sept. 30th, 1921.

Formation.	Thickness of Formation.	Total Length.
Surface	82 Feet	82 Feet
Lime and Shale	180 "	262 "
Niagara	218 "	480 "
Shale	50 "	530 "
Clinton Rock	30 "	560 "
Red Medina	45 "	605 "
Shale	55 "	660 "
White Medina	12 "	672 "
Red Shale	51 "	723 "

Total Depth................ 723 Feet.

Gas at 535 feet.

Log No. 68; Information by Hoover & May, Selkirk.

Lot.	Concession.	Township.	County.
4	2	Seneca.	Haldimand.

Open flow: 29,000 cu. ft.
Rock pressure: 215 lbs.

Completed Dec. 24th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	38 Feet	38 Feet
Shale	93 "	131 "
Niagara	197 "	328 "
White Lime	31 "	359 "
Shale	34 "	393 "
Clinton	32 "	425 "
Red Medina	37 "	462 "
Grey Shale	54 "	516 "
White Medina	27 "	543 "
Red Shale	57 "	600 "

Total Depth................ 600 Feet.

Log No. 69; Information by Hoover & May, Selkirk.

Lot.	Concession.	Township.	County.
3	2	Seneca.	Haldimand.

Open flow: 29,000 cu. ft.
Rock Pressure: 219 lbs.

Completed Jan. 14th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	48 Feet	48 Feet
Shale	88 "	136 "
Niagara	192 "	328 "
White Lime	17 "	345 "
Shale	34 "	379 "
Clinton	32 "	411 "
Red Medina	39 "	450 "
Grey Shale	54 "	504 "
White Medina	29 "	533 "
Red Shale	62 "	595 "

Total Depth................. 595 Feet.

Log No. 70; Information by J. A. Coleman, Wellandport

Lot.	Concession.	Township.	County.
15	2	Moulton.	Haldimand.

Completed Nov. 28th, 1919.

Formation.	Thickness of Formation.	Total Depth
Surface	26 Feet	26 Feet
Lime Stone	141 "	167 "
Niagara	160 "	327 "
White Sand	20 "	347 "
Slate	50 "	397 "
Clinton	34 "	431 "
Red Medina	35 "	466 "
Slate	55 "	521 "
White Medina	10 "	532 "
Red Shale	68 "	600 "

Total Depth............ 600 Feet.

Log No 71; Information by F. L. Snively, Hamilton.

Lot.	Concession.	Township.	County
21	7	Binbrook	Wentworth.

Open flow: 40,000 cu. ft.
Rock pressure: 125 lbs.

Completed Oct. 1st, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	42 Feet	42 Feet
Brown Lime	83 "	125 "
Niagara	120 "	245 "
Grey Casing Shale	40 "	285 "
Clinton	35 "	320 "
Red Medina	43 "	363 "
Blue Shale	55 "	418 "
White Medin	10 "	433 "
Red Shale	50 "	483 "

Total Depth .... 483 Feet.

Log No. 72; Information by F. L. Snively, Hamilton.

Lot.	Concession.	Township.	County.
4	3	Binbook.	Wentworth.

Dry hole.

Completed July 5th, 1921

Formation.	Thickness of Formation.	Total Depth.
Clay	17 Feet	71 Feet
Brown Lime	76 "	147 "
Niagara	115 "	262 "
Grey Shale	40 "	302 "
Clinton	30 "	332 "
Red Medina	35 "	367 "
Blue Shale	55 "	422 "
White Medina	10 "	432 "
Red Shale	9 "	441 "

Total Depth .... 441 Feet.

Log No. 73; Information by Wm. McKillop, Hepworth.

Lot.	Concession.	Township.	County.
10	I	Flamboro West	Wentworth.

Open Flow: 6,000 cu. ft.

Completed April 6th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	231 Feet	231 Feet
Red Shale	200 "	431 "
Hudson	639 "	1,070 "
Black Shale	205 "	1,275 "
Trenton	793 "	2,068 "
Potsdam	55 "	2,123 "

Total Depth .... 2,123 Feet
Gas at 296, 1,280 and 1,970 Feet.

LOG NO. 74; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
1	4	Binbrook.	Wentworth.

Dry hole. Completed Feb. 19th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	64 Feet	64 Feet
Brown Lime	76 "	140 "
Niagara	115 "	255 "
Casing Shale	40 "	295 "
Clinton	30 "	325 "
Red Medina	35 "	360 "
Blue Shale	55 "	415 "
White Medina	10 "	425 "
Total Depth	425 Feet.	

LOG NO. 75; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
4	4	Binbrook.	Wentworth.

Open flow: 50,000 cu. ft.
Rock pressure: 150 lbs. Completed June 15th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	76 Feet	76 Feet
Brown Lime	76 "	152 "
Niagara	115 "	267 "
Casing Shale	40 "	307 "
Clinton	30 "	337 "
Red Medina	35 "	372 "
Blue Shale	55 "	427 "
White Medina	10 "	437 "
Red Shale	50 "	487 "
Total Depth	487 Feet.	

Gas at 337, 357 and 437 feet.

LOG NO. 76; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
20	4	Binbrook.	Wentworth.

Open flow: 40,000 cu. ft.
Rock pressure: 125 lbs. Completed Aug. 2nd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay and Stone	80 Feet	80 Feet
Brown Lime	72 "	152 "
Niagara	110 "	262 "
Grey Shale	40 "	302 "
Clinton	30 "	332 "
Red Medina	32 "	364 "
Blue Shale	54 "	418 "
White Medina	10 "	428 "
Red Shale	50 "	478 "
Total Depth	478 Feet.	

Gas at 332, 364 and 428 feet.

LOG NO. 77; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
20 blk. 4.	4	Binbrook.	Wentworth.

Open flow: 40,000 cu. ft.
Rock pressure: 125 lbs.

Completed Aug. 24th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	60 Feet	60 Feet
Brown Lime	76 "	136 "
Niagara	115 "	251 "
Grey Casing Shale	35 "	286 "
Clinton	30 "	316 "
Red Medina	35 "	351 "
Blue Shale	55 "	406 "
White Medina	12 "	418 "
Red Shale	50 "	468 "
Total Depth	468 Feet.	

Gas at 316, 351 and 418 feet.

LOG NO. 78; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
19	7	Binbrook.	Wentworth.

Open flow: 40,000 cu. ft.
Rock pressure: 120 lbs.

Completed Sept. 12th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	48 Feet	48 Feet
Brown Lime	76 "	124 "
Niagara	115 "	239 "
Grey Casing Shale	40 "	279 "
Clinton	30 "	309 "
Red Medina	40 "	349 "
Blue Shale	55 "	404 "
White Medina	12 "	416 "
Red Shale	50 "	466 "
Total Depth	466 Feet.	

Gas at 309, 349 and 416 feet.

LOG NO. 79; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
4	S. McKennall Farm.	Binbrook.	Wentworth.

Open flow: 40,000 cu. ft.
Rock pressure: 150 lbs.

Completed June 15th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	78 Feet	78 Feet
Brown Lime	76 "	154 "
Niagara	115 "	269 "
Grey Shale	40 "	309 "
Clinton	30 "	339 "
Red Medina	35 "	374 "
Blue Shale	55 "	429 "
White Medina	10 "	439 "
Red Shale	48 "	487 "
Total Depth	487 Feet.	

LOG NO. 80; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
4	4	Binbrook.	Wentworth.

Dry hole. Completed Jan. 22nd, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	79 Feet	79 Feet
Brown Lime	76 "	155 "
Niagara Lime	115 "	270 "
Casing Shale	40 "	310 "
Clinton	30 "	340 "
Red Medina	35 "	375 "
Blue Shale	55 "	430 "
White Medina	10 "	440 "
Red Shale	3 "	443 "
Total Depth	443 Feet.	

LOG NO. 81; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
4	3 Near Halls Corners	Binbrook.	Wentworth.

Open flow: 40,000 cu. ft.
Rock pressure: 150 lbs.
Completed May 24th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	78 Feet	78 Feet
Brown Lime	76 "	154 "
Niagara	115 "	269 "
Casing Shale	40 "	309 "
Clinton	30 "	339 "
Red Medina	35 "	374 "
Blue Shale	55 "	429 "
White Medina	10 "	439 "
Red Shale	48 "	487 "
Total Depth	487 Feet.	

LOG NO. 82; INFORMATION BY F. L. SNIVELY, HAMILTON.

Lot.	Concession.	Township.	County.
S½-1 & 2	4 Near Halls Corners	Binbrook.	Wentworth.

Dry hole Completed Feb. 19th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Clay	64 Feet	64 Feet
Brown Lime	76 "	140 "
Niagara	115 "	255 "
Casing Shale	40 "	295 "
Clinton	30 "	325 "
Red Medina	35 "	360 "
Blue Shale	55 "	415 "
White Medina	10 "	425 "
Total Depth	425 Feet.	

Log No. 83; Information by Wm. McKillop, Hepworth.

Lot.	Concession.	Township.	County.
28	1	Beverly.	Wentworth.

Completed Sept. 1921.

Formation.	Thickness of Formation.		Total Depth.	
Clay	18	Feet	18	Feet
Quick Sand	192	"	210	"
Red Clay	14	"	224	"
Sand	161	"	385	"
Coarse Water Sand	55	"	440	"
Quick Sand	90	"	530	"
Sand and Gravel	7	"	537	"
Total Depth	537	Feet.		

Log No. 84; Information by Kiser & Louer, Tillsonburg.

Lot.	Concession.	Township.	County.
78	13	N. Walsingham.	Norfolk.

Open flow: 43,000 cu. ft.
Rock pressure: 605 lbs..

Formation.	Thickness of Formation.		Total Depth.	
Surface	208	Feet	208	Feet
Lime	155	‘	363	"
Flint	50	"	413	"
Sharp Sand	80	"	493	"
Hard Lime	54	"	547	"
Lime and Shale	84	"	631	"
Brown Lime	102	"	733	"
Hard Lime	151	"	884	"
Niagara Lime	257	"	1,141	"
Shale	67	"	1,208	"
Clinton	27	"	1,235	"
Red Medina	5	"	1,240	"
Grey Shale	24	"	1,264	"
Total Depth	1,264	Feet.		

Log No. 85; Information by Wesley Hamaker, Port Dover.

Lot.	Concession.	Township.	County.
2	B. F.	Woodhouse.	Norfolk.

Open flow: 178,000 cu. ft.
Rock pressure: 555 lbs.

Formation.	Thickness of Formation.		Total Depth.	
Surface	116	Feet	116	Feet
Flint	159	"	275	"
Sand	47	"	322	"
Lime	51	"	373	"
Lime and Shale	293	"	666	"
Niagara Lime	299	"	965	"
Shale	44	"	1,009	"
Clinton	23	"	1,032	"
Red Medina	20	"	1,052	"
Grey Shale	76	"	1,128	"
White Medina	28	"	1,156	"
Red Shale	1	"	1,157	"
Total Depth	1,157	Feet.		

Log No. 86; Information by Kiser & Louer, Tillsonburg.

Lot.	Concession.	Township.	County.
10	“B”	Walsingham.	Norfolk.

Open flow: 18,000 cu. ft.
Rock pressure: 475 lbs.

Formation.	Thickness of Formation.	Total Depth.
Surface	313 Feet	313 Feet
Lime	137 “	450 “
Flint	150 “	600 “
Niagara Lime	200 “	800 “
Shale	69 “	869 “
Clinton	20 “	889 “
Red Medina	27 “	916 “
Shale	5 “	921 “
Total Depth	921 Feet.	

Log No. 87; Information by George Williams, Delhi.

Lot.	Concession.	Township.	County.
31	3	Middleton.	Norfolk.

Open flow: 75,000 cu. ft.
Rock pressure: 550 lbs.

Formation.	Thickness of Formation.	Total Depth.
Surface	206 Feet	206 Feet
Lime	140 “	346 “
Flint	52 “	398 “
Sharp Sand	80 “	478 “
Hard Lime	52 “	530 “
Lime and Shale	83 “	613 “
Brown Lime	102 “	715 “
Hard Lime	150 “	865 “
Niagara Lime	257 “	1,122 “
Shale	41 “	1,163 “
Clinton	30 “	1,193 “
Red Medina	5 “	1,198 “
Grey Shale	34 “	1,232 “
Total Depth	1,232 Feet.	

Log No. 88; Information by Wesley Hamaker, Port Dover.

Lot.	Concession.	Township.	County.
1	Broken Front.	Woodhouse.	Norfolk.

Rock pressure: 485 lbs. Completed Nov. 7th, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	136 Feet	136 Feet
Lime	100 “	236 “
Flint	80 “	316 “
Sand	32 “	348 “
Lime	110 “	458 “
Lime and Shale	80 “	538 “
Lime	110 “	648 “
Shale	60 “	708 “
Niagara	272 “	980 “
Shale	60 “	1,040 “
Clinton	25 “	1,065 “
Red Medina	25 “	1,090 “
Shale	70 “	1,160 “
White Medina	17 “	1,177 “
Red Shale	2 “	1,179 “
Total Depth	1,179 Feet.	

Log No. 89; Information by H. Cable.

Lot.	Concession.	Township.	County.
Lever Farm. 135	3 U.S.R.	Artemesia.	Grey.

Drilled in 1917.

Formation.	Thickness of Formation.	Total Depth.
Surface	28 Feet	28 Feet
Niagara Lime	202 "	230 "
Blue Shale	40 "	270 "
Brown or Grey Rock	30 "	300 "
Blue Shale	5 "	305 "
Red Medina	265 "	370 "
Hudson River	400 "	770 "
Utica (brown)	170 "	940 "
Trenton Lime	40 "	980 "
Blue Shale and Gypsum	60 "	1,040 "
Trenton with Streaks of Shale	35 "	1,075 "
Shale and Slate	40 "	1,115 "
Gypsum and Conglomerate	25 "	1,140 "
Grey Rock	55 "	1,195 "
Trenton and Shale	100 "	1,295 "
Grey and blue rock	60 "	1,355 "
Trenton	185 "	1,540 "
Total Depth	1,540 Feet.	

Gas at 1645 and 1,695 feet.

Oil at 1,715 feet.

Trenton lime conglomerate with shale gypsum and Potsdam sands to a depth of 1873 feet where Trenton lime ceases to show.

Log No. 90; Information by W. H. McDonald, Oshawa.

Lot.	Concession.	Township.	County.
24	7	St. Vincent.	Grey.

Completed July, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	10 Feet	10 Feet
Collingwood Shale	40 "	50 "
Hudson Shale	170 "	220 "
Utica Shale	60 "	280 "
Trenton	676 "	956 "
Arkose	20 "	976 "
Total Depth	976 Feet.	

Log No. 91; Information by A. E. Hoover, Selkirk.

Lot.	Concession.	Township.	County.
16	1	Toronto.	Peel.

Completed Sept. 1920.

Formation.	Thickness of Formation.	Total Depth.
Surface	4 Feet	4 Feet
Hudson River	603 "	607 "
Utica	178 "	785 "
Trenton	605 "	1,390 "
Different Rocks	32 "	1,422 "
Granite	3 "	1,425 "
Total Depth	1,425 Feet.	

Log No. 92; Information by Jas. Pickering, Shelbourne.

Lot.	Concession.	Township.	County.
2	3	Melancthon.	Dufferin.

Drilled in 1907.

Formation.	Thickness of Formation.	Total Depth.
Surface	25 Feet	25 Feet
Niagara	115 "	140 "
Dolomite	20 "	160 "
Clinton	50 "	210 "
Blue Clay	100 "	310 "
Red Shale	320 "	630 "
Blue Shale	370 "	1,000 "
Soft Slate	225 "	1,225 "
Utica Shale	75 "	1,300 "
Trenton	650 "	1,950 "

Total Depth . . . . 1,950 Feet.

Log No. 93; Information by Kiser & Louer, Tillsonburg.

Lot.	Concession.	Township.	County.
33	1	Malahide.	Elgin.

Open flow: 70,000 cu. ft.

Completed, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	268 Feet	268 Feet
Lime	212 "	480 "
Flint	160 "	640 "
Lime	460 "	1,100 "
Niagara Lime	245 "	1,345 "
Shale	55 "	1,400 "
Clinton	22 "	1,422 "
Red Medina	30 "	1,452 "
White Shale	30 "	1,482 "
White Medina	35 "	1,517 "
Red Shale	5 "	1,522 "

Total Depth . . . . 1,522 Feet.

Log No. 94; Information by Kiser & Louer, Tillsonburg.

Lot.	Concession.	Township.	County.
34	1	Malahide.	Elgin.

Open flow: 201,000 cu. ft.
Rock pressure: 585 lbs.

Completed, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	280 Feet	280 Feet
Lime	220 "	500 "
Flint	150 "	650 "
Lime	425 "	1,075 "
Niagara Lime	285 "	1,360 "
Shale	54 "	1,414 "
Clinton	25 "	1,439 "
Red Medina	10 "	1,449 "
White Shale	36 "	1,485 "

Total Depth . . . . 1,485 Feet.

Log No. 95; Information by Kiser & Louer, Tillsonburg.

Lot.	Concession.	Township.	County.
35	2	Malahide.	Elgin.

Dry hole. Completed Oct. 21, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	277 Feet	277 Feet
Lime	203 "	480 "
Flint	150 "	630 "
Lime	445 "	1,075 "
Niagara	280 "	1,355 "
Shale	60 "	1,415 "
Clinton	16 "	1,431 "
Red Medina	13 "	1,444 "
Total Depth	1,444 Feet.	

Log No. 96; Driller Geo. King, Strathroy.

Lot.	Concession.	Township.	County.
7	5	Adelaide.	Middlesex.

Completed, 1921.

Formation.	Thickness of Formation.	Total Depth.
Surface	142 Feet	142 Feet
Top Rock	20 "	162 "
Soap	30 "	192 "
Black Lime	14 "	206 "
Grey Lime	52 "	258 "
Lime	100 "	358 "
Total Depth	358 Feet.	

Oil at 258 and 300 feet.

Log No. 97; Information by Driller Geo. King, Strathroy.

Lot.	Concession.	Township.	County.
7	5	Adelaide.	Middlesex.

Completed June 15th, 1921

Formation.	Thickness of Formation.	Total Depth.
Surface	145 Feet.	145 Feet
Top Rock	20 "	165 "
Soap	30 "	195 "
Lime	76 "	271 "
Total Depth	271 Feet.	

Gas at 209, 230 and 245 feet.

Log No. 98; Information by Driller Geo. King, Strathroy.

Lot.	Concession.	Township.	County.
7	5	Adelaide.	Middlesex.

Formation.	Thickness of Formation.	Total Depth.
Surface	155 Feet	155 Feet
Top Rock	20 "	175 "
Soap	30 "	205 "
Lime	72 "	277 "
Total Depth	277 Feet.	

Log No. 99; Information by Driller F. L. Snively, Hamilton.

Lot.	1st Concession South	Township.	County.
4	Dundas Road	North Dorchester.	Middlesex.

Saul Farm. Completed Feb. 8th, 1921

Open flow: 237,000 cu. ft.
Rock pressure: 160 lbs.

Formation.	Thickness of Formation.	Total Depth.
Clay	125 Feet	125 Feet
Grey Limestone	54 "	179 "
Brown Lime	358 "	537 "
White Lime	39 "	576 "
Grey Lime and Hard Shale	149 "	725 "
Gypsum	56 "	781 "
Hard Shale	144 "	925 "
Guelph Lime	55 "	980 "
Hard Shale	25 "	1,005 "
Total Depth	1,005 Feet.	

Log No. 100; Information by Driller F. L. Snively, Hamilton.

Lot.	1st Concession South.	Township.	County.
3	Dundas Road.	North Dorchester.	Middlesex.

Dry hole. Completed May 14th, 1921

Formation.	Thickness of Formation.	Total Depth.
Clay	139 Feet	139 Feet
Grey Limestone	54 "	193 "
Brown Lime	358 "	551 "
White Lime	39 "	590 "
Grey Lime and Hard Shale	149 "	739 "
Gypsum	56 "	795 "
Hard Shale	143 "	938 "
Salt Bed	35 "	973 "
Hard Shale	77 "	1,050 "
Total Depth	1,050 Feet.	

PETROLEUM IN 1921

The quantity of crude petroleum produced in Ontario in 1921 was 172,859 barrels of 35 Imperial gallons; 8,891 barrels less than in 1920. The principal cause of this decline is that the supply in two of the fields is giving out. There are other reasons also; the low price of oil, which fell from $4.09 per barrel in January to $1.98 in July, August and September, undoubtedly lessened the output. A glance at table 1, which gives the number of wells not operating, will show that, had the price been more stable, more properties would have been worked.

TABLE I.—CRUDE PETROLEUM PRODUCED IN 1921.

Field	Production		Wells			Average Production per operating Well	Gain or Loss in Production in 1921	
	bbls.	gals.	Operating	Non-Operating	Abandoned	bbls.	Gain bbls.	Loss bbls.
Petrolia and Enniskillen	68,483	32	1,681	859	125	40.74	3,402	......
Oil Springs	40,966	22	1,192	82	37	31.85	1,579	......
Moore Tp	7,536	04	94	15	26	80.27	500	......
Sarnia Tp	4,068	20	111	30	24	36.65	574	......
Plympton Tp	480	21	30	21	22	16.00	......	51
Bothwell	26,877	01	252	42	30	106.64	313	......
Tilbury East Tp	1,002	29	(a) 6	......	......	......	379	......
Dover West Tp	7,473	10	7	......	......	1,067.60	......	4,697
Raleigh Tp	3,320	13	20	......	4	166.00	2,832	......
Onondaga Tp	566	06	15	6	......	37.74	226	......
Mosa Tp	10,764	03	53	67	......	203.00	......	13,299
Thamesville	1,319	20	4	......	......	660.00	189	......
Belle River	......	......	......	24	......	......	......	......
Dutton	......	......	......	76	......	......	......	837
Total	172,858	32	3,465	1,222	268	......	9,994	18,884
							Net Loss	8,890

(a) Production mainly from a large number of gas wells.

An examination of Table I, "gain and loss," shows, in spite of a general loss, a successful year's operations. With the exception of the Raleigh field, all the fields are old. The Petrolia field is entering its 60th year of continuous production, and after many years of gradual decline shows an increase of over 3,000 barrels, all without any new drilling. This is believed to be due, first to Inspector John Scott's diligence in searching out and plugging the abandoned wells that have been allowing surface water to flood the "oil sand." A glance at Table I, column "Wells not operating" will show that this is no simple matter. With so many idle wells, any of which might be leaking, it may mean that a score of them must be tested. Second; to the increased use of electric power for pumping oil wells; electric power is surer and steadier than gas engine power and increases production. The gas engine may stop in the evening, and wells idle for 10 hours may require days of pumping before oil will appear again. The other fields in Lambton county are practically as old as the Petrolia field, and are very similar.

The Raleigh field is mainly in the northwest corner of the township. The discovery of this field was noted in last year's report, and Dr. M. Y. Williams may fairly be given most of the credit for the discovery. It might still be enlarged. The limits are fairly well known, and it would appear that many more producing wells could be drilled, and the production greatly increased.

The increases shown in Tilbury East and Onondaga are more apparent than real, owing to an accumulation of crude petroleum shipped in January, which was really produced in 1920.

The sudden failure of the Mosa (Glencoe) field offsets the increase in the other fields. This heretofore excellent field only produced forty-five per cent. of its production in 1920. No reason can be given for this sudden failure excepting natural causes. However, a careful inspection of the sources of water might throw light on the decline. The West Dover field that has been a "flowing" one has been failing during the year on account of the depletion of the gas in the wells. The operating companies are installing pumps, and no doubt the year 1922 will show an improvement. The Thamesville field closed down in May owing to a disastrous fire that destroyed the pumping plant. The Dutton and Belle River fields were apparently inactive this year, although four wells are reported as operating at Belle River, and some of the wells in the Dutton field are reported as being "bailed." However, no oil was marketed from either field.

TABLE II.—CRUDE PETROLEUM PRODUCTION(1), BY FIELDS, 1917-1921.

Field	1917	1918	1919	1920	1921
	Bbls.	Bbls.	Bbls.	Bbls.	Bbls.
Petrolia and Enniskillen	74,267	65.467	70,087	65,082	68.483
Oil Springs	46,902	44,671	45,245	39.388	40,966
Moore township	6,282	6,367	4,029	7,036	7,536
Sarnia township	4,494	3,438	4,259	3.495	4,068
Plympton township	579	412	560	531	480
Bothwell	29,682	29,116	29,425	25,563	26,877
Dover, West } Tilbury	10,041	25,228	16,705	12,171	7.473
Tilbury, East }			1.660	623	1,002
Raleigh township				(2)	3,320
Dutton	2,941	1,875	1,272	837	
Onondaga township	383	1,186	197	341	566
Belle River		447			
Mosa township	20,999	108,988	45,860	24,063	10,764
Thamesville	6,420	1,565	801	1,131	1,319
Total Production Bbls.	202,990	288,760	220.100	181,750	172,858
Value $	475.000	781,097	632,789	724,145	466,716
Average price per Bbl. (3) $	2.34	2.70½	2.87½	3.98½	2.68½

(1) Figures supplied to the Ontario Department of Mines by J. C. Waddell, Supervisor of Petroleum Bounties, Petrolia.

(2) Production for 1920 in Raleigh township was included with that of Dover West.

(3) A bounty of 52½ cents per barrel (35 Imperial gallons) or a total of $90,748.78 was paid in addition by the Federal Government under The "Petroleum Bounty Act."

Drilling Operations

Probably on account of the falling price of petroleum, there was little drilling activity during the year. Only two oil wells were drilled in Lambton county, both being in Moore township, and small producers.

In the Raleigh field the Eureka Oil and Gas Company drilled two wells, the Ajax Company four, the Pens Oil and Gas Company six, and the Inland Oil and Gas Company one dry hole.

John L. Hutton drilled a well on lot 27, con. 1, Mosa township, near Bothwell, a dry hole.

No other drilling activities are recorded in the old fields.

Exploratory Drilling

Several operators have turned their attention to Middlesex county, and much land has been leased over a very widespread area.

Actual drilling operations were begun by Messrs. Johnson and Hyett, Arkona, on a Trenton well not finished.

Bert Keyser started in 1920, and has drilled three shallow wells at Keyser's Corners.

The Central Ontario Petroleum Company has drilled two wells south of Kerwood; both had some oil, but the yield is not reported.

In the Kent county field, E. P. Rowe put down a shallow test well in lot 15, con. II Harwich, a dry hole.

The Valley Oil and Gas Company drilled a well to the granite one mile southwest of Dundas Station with a show of both oil and gas in the Trenton limestone.

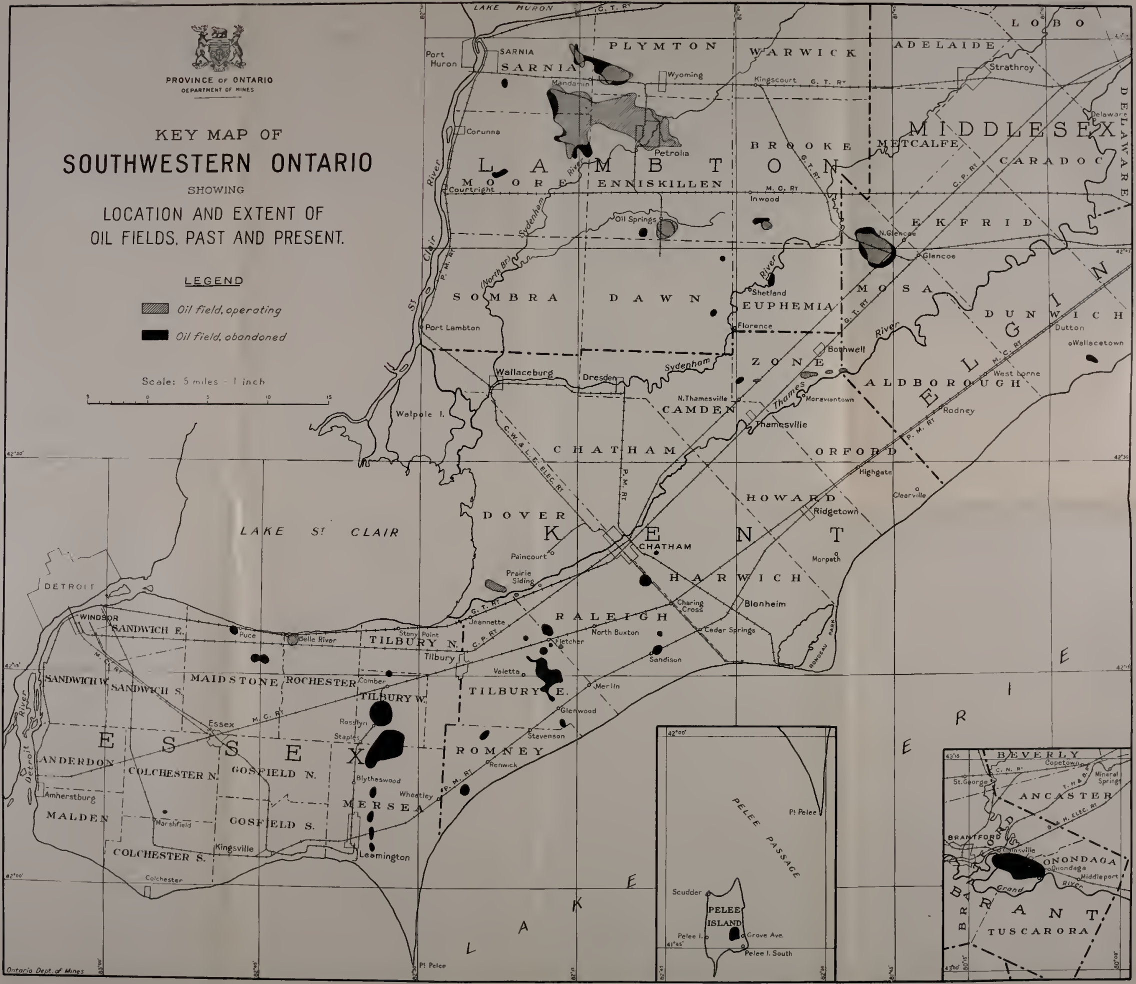
Modern (standard) drilling rig.

R. I. Henderson commenced a well two miles northeast of Bronte but has not completed it. Some gas was found in the Hudson River formation, but so far as known the Trenton was dry.

The Canadian Oil Fields, Limited, are drilling a well two miles east of Shelburne. No oil or gas is reported in the formations above the Potsdam sands, but this company claims to have a percentage of heavy oil in the rock 500 to 600 feet below the bottom of the Trenton limestone.

Some drilling was done in Manitoulin Island, but no reports have been received of the results.

Capt. C. M. McCarthy has a party organized to drill for oil with a diamond drill on the Mattagami river about 100 miles north of the Transcontinental railway. His party left on December 27th, and no reports will be received from him until the spring. He is using dog teams to take his supplies and equipment into this uninhabited country.



PROVINCE OF ONTARIO
DEPARTMENT OF MINES

KEY MAP OF
SOUTHWESTERN ONTARIO
SHOWING
LOCATION AND EXTENT OF
OIL FIELDS, PAST AND PRESENT.

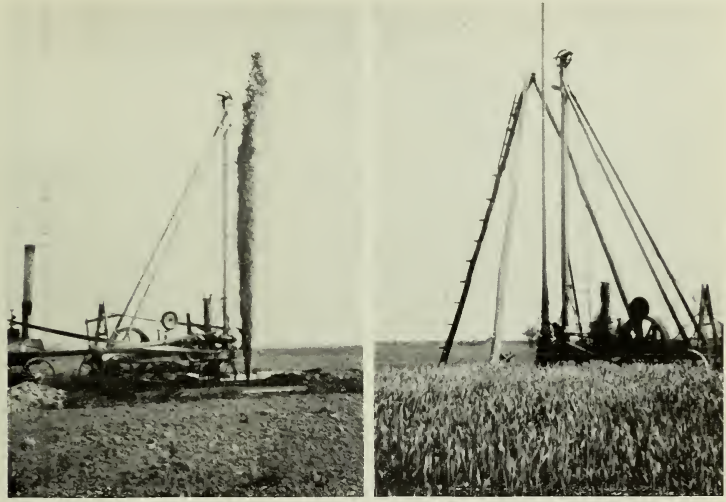
LEGEND

▨ *Oil field, operating*

■ *Oil field, abandoned*

Scale: 5 miles = 1 inch

To Accompany Report on Petroleum in 1921, by R. B. Harkness. Vol. XXXI, Part V, 1922



The right way

The wrong way

Shooting an Oil Well

When the casing is poorly seated or where the fluid level is above the bottom of the casing the escaping gases and debris are likely to lift the casing out. Of course misfortune may attend a well-placed shot, and even the debris escaping may lodge in the casing, and the compressed gasses force the casing out of the well. In the upper right hand picture the latter may have been the cause, as the fluid can be clearly seen shooting up between the drive-pipe and the string of casing that is being blown out of the well.

Map of Oil Fields

The map showing the oil fields of Ontario, past and present, is published to preserve the history of the oil development in Ontario as well as to serve as a reference for future development. Enquiries are often made as to where oil has been found in Ontario, and it is hoped that this will be of value to prospectors. It is not possible to show on a small scale all the test wells that have been drilled and have proved unproductive, but a very complete record of these wells is kept in the Natural Gas Commissioner's office and is available for reference by any one interested.

The original boundaries of the old oil fields are difficult to arrive at accurately, as the information must be got from the memory of the old operators, which is not always reliable. Neither do any of the old reports contain any accurate record of the limits of the old fields.

Acknowledgments are due for information received to Mr. Bookmiller of Tilbury, C. C. Roberts of Brantford, D. A. Coste of Niagara Falls, and many individual property owners on whose farms wells have been drilled.

Refining Operations

Four refineries operated in the Province in 1921, as noted hereunder:

PETROLEUM REFINERIES, 1921.

COMPANY	LOCATION OF REFINERY	DAYS OPERATED	HEAD OFFICE ADDRESS
British American Oil Co., Ltd	Toronto, Cherry St	314	Toronto, Royal Bank Bldg.
Canadian Oil Companies, Limited	Petrolia	309	Toronto, Excelsior Life Bldg.
†Cities Service Oil Co., Ltd	Wallaceburg	306	Wallaceburg.
Imperial Oil, Limited	Sarnia	312	Sarnia.

†This company took over the Great Lakes Oil Company's refinery on Mar. 1, 1921.

The following table, summarized from annual reports of the Ontario Department of Mines for the years 1907-1921 and Dominion Bureau of Statistics for 1921, shows refinery operations for the past five years:

TABLE III.—STATISTICS OF PETROLEUM REFINERIES, 1917-1921.

SCHEDULE	1917	1918	1919	1920	1921
Crude petroleum production					
Imp. gals	7,104,700	10,106,615	7,703,515	6,361,234	6,050,062
Value " $	475,000	781,097	632,789	724,145	466,716
American Crude, distilled,					
Imp. gals	122,436,923	137,065,788	141,157,309	148,540,511	150,692.113
Value " $	9,236,033	12,612,882	12,486,174	20.102.784	14,537,339
Canadian Crude, distilled,					
Imp. gals	8,122,062	9,513,222	7,693,385	6,402,118	5,880,086
Value " $	559,435	781,703	661,927	769,775	500,418
Per cent. of total	6.22	6.49	5.17	4.13	3.75
Products:					
Illuminating oil ... Imp. gals.	40,195,774	36,211,715	34,800,233	33,897,891	29,774,134
Value " $	3,457,817	4,239,816	5,073,647	6,331,706	3,335,200
Lubricating oil ... Imp. gals.	12,288,466	12,595,305	12,501,385	13,804,074	13,848,721
Value " $	1,586,270	2,118,002	2,293,640	3,276,569	2,351,975
Benzine, Naphtha, Gasoline ... Imp. gals.	34,611,056	39,156,447	44,625,590	47,418,420	51,033,337
Value " $	8,292,828	10,244,328	11,677,077	14,485,935	12,655,244
*Gas and Fuel oil, Tar, Imp. gals.	39,815,106	40,949,358	40,581,499	45,025,050	44,364,794
Value " $	2,671,414	2,943,503	2,265,457	5,486,636	2,130,685
Paraffin Wax and Candles. lbs.	12,649,553	13,650,128	10,903,202	10,398,127	10,777,994
Value " $	908,996	1,148,726	1,044,798	973,805	310,267
Employees ... Ave. No.	1,289	1,312	1,580	1,736	1,560
Wages paid ... $	1,259,344	1,486,677	2,045,072	2,695,507	2,176,700

*Figures for 1921 do not include Tar product which was 18,971,400 pounds with selling value of $142,285.00.

INDEX
Vol. XXXI, Part V.

PAGE

- Abray, Thomas 26
- Acetylene.
  - Compared with natural gas 32
- Adelaide tp., boring records 70
- Ajax Oil and Gas Co. 46, 73
- Aldboro tp.
  - Gas consumption: population 18
  - Wells drilled 27
- Aldrich Gas and Oil Co. 23
- Amabel tp., wells drilled 27
- Ancaster tp. 19
- Artemesia tp., borings 68
- Artificial gas.
  - Compared with natural gas 32
- Aylmer.
  - Gas consumption; population 17
    - for industries 20
- Azoff Natural Gas Co. 25

- Bailing machine.
  - Description and photo 34-36
- Barton tp. 19
- Battle Natural Gas Co. 23
- Bayham tp.
  - Gas consumption: population 18
  - Wells drilled 27
- Beaver Oil and Gas Co. 23, 24, 26
- Beer, George 25
- Belle River.
  - Gas consumption: population 17
    - for industries 20
  - Oil field 72, 73
- Belmont.
  - Gas consumption 17
    - for industries 20
- Belmont Gas Light Co. 25
- Bermingham, T. C. 26
- Berry and Anderson 24
- Bertie tp.
  - Gas consumption; population 19
  - Wells drilled 27
- Beverly tp.
  - Boring records 66
  - Wells drilled 27
- Binbrook tp.
  - Gas consumption: production 19
  - Wells 27
    - records 62-65
- Binbrook Gas Co. 23, 25
- Blenheim.
  - Gas consumption: population 17
    - for industries 20
    - meter, orifice 4
- Bookmiller, Mr. 75
- Boring for gas.
  - Dufferin co. 69
  - Elgin co. 69, 70
  - Essex co. 48
  - Grey co. 68
  - Haldimand co. 50-61
  - Kent co. 38-47

PAGE

- Boring for gas—*continued.*
  - Middlesex co. 70, 71
  - Norfolk co. 66, 67
  - Operators licensed, list 24
  - Peel co. 69
  - Welland co. 49
  - Wells sunk, township list 27
  - Wentworth co. 62-66
- Boring for oil 73-75
- Bothwell oil field 73
- Brant co.
  - Gas consumption: population 18
    - wells sunk in 1921 27
- Brantford.
  - Gas consumption 17
    - peak, graph 14
    - for industries 20
    - rate of flow, diagrams 11
  - Population 17
- Brantford Gas Co. 25
- Bridgeburg.
  - Gas consumption: population 17
    - for industries 20
- British American Oil Co. 76
- Bronte. 74
- Brown, Geo. D. 46, 47
- Bruce co., gas wells 27
- Bunn, Forest 26
- Burners.
  - Method of altering, for economical cooking 4
- Burn, B. D. 3

- Cable, H. 68
- Caistor tp.
  - Gas consumption: population 19
    - wells 27
- Caledonia.
  - Gas consumption: population 17
    - for industries 20
- Camden tp. 18
- Canadian Oil Companies, Ltd. 76
- Canboro Gas and Oil Co. 23
- Canborough tp.
  - Boring for gas 27
    - records 59
  - Gas consumption: population 19
- Canby, B. F. 23
- Canfield Natural Gas Co. 23
- Castle Oil and Gas Co. 23-26
- Cayuga.
  - Gas consumption: population 17
- Cayuga tps.
  - Boring records 57, 58
  - Gas consumption: population 19
    - wells 27
- Central Ontario Petroleum Co. 74
- Central Pipe Line Co.
  - Appeal to adjust prices 3
  - Licenses to 24, 25
- Chamberlain, H. A. 24

PAGE
Charlotteville tp.
  Gas consumption: population ... 18
    wells ... 27
Chatham.
  Gas consumption: population .. 17
    for industries ... 20
    pressure ...2, 3, *Facing* 13
Chatham tp. ... 18
Chatham Gas Co. ... 25
Chippawa ... 17
Chippawa Development Co. ...23, 25
Chippawa Oil and Gas Co. ...23, 25
Cities Service Oil Co. ... 76
Clover Gas and Oil Co. ... 24, 26
Coatsworth ... 20
Coleman, J. A. ... 24, 61
Comber ... 20
Competition.
  Inadvisable in gas industry ... 34
Consumers of gas, statistics ... 17-19
Contracts, percentage. *See* Percentage contracts.
Cooking by gas.
  Notes on economical methods ... 5-7
Copetown ... 28
Coste, D. A. ... 75
Courtright.
  Gas consumption: population .. 17
    for industries ... 20
Crowland tps.
  Gas consumption: population .. 19
    wells ... 27
      records ... 49

Danville ... 17
Darling Road Co-operative Co. ... 23
Dawn tp.
  Gas, new field ... 28
    wells ... 27
      record ... 49
Delhi.
  Gas consumption: population .. 17
    for industries ... 20
Dominion Natural Gas Co.
  Boring at Lakeview ... 28
  Licenses to ... 23-26
Dorchester tps.
  Gas consumption: population ... 18
    wells, records ... 71
Dover tps.
  Gas, consumption: ... 18
    meter, orifice ... 4
    wells ... 27
      records ... 44, 45
  Oil production ... 72, 73
  Population ... 18
Dresden.
  Gas consumption: population ... 17
    for industries ... 20
    meter, orifice ... 4
Drilling operations. *See* Boring for gas and oil.
Drilling rig, photo ... 74
Dumfries tp. ... 18
Dundas.
  Gas, consumption: population .. 17
    for industries ... 20

PAGE
Dundas—*continued.*
    meter, orifice ... 4
    new well ... 28
    price ... 22
  Oil, new well ... 28, 74
Dunn tp.
  Gas, consumption: population .. 19
    wells ... 27
Dunn Natural Gas Co. ... 25
Dunnville ... 20
Dunwich tp. ... 18
"Dust" trap, notes and photo ... 15
Dutton.
  Gas consumption: population ... 17
    for industries ... 20
    price ... 22
  Oil field, production ... 72, 73

Economy in using gas.
  Notes by Ohio State University .. 5-7
Electricity.
  Compared with natural gas ... 30
Elgin co.
  Gas consumption ... 18
    wells ... 27
      records ...69, 70
  Population ... 18
Emerson, Laidlaw and Troughton 23
Empire Limestone Co. ... 23
Enniskillen oil field, production .. 72, 73
Enniskillen tp.
  Gas consumption: population .. 18
    wells ... 27
Essex.
  Gas consumption: poulation ... 17
    for industries ... 20
Essex co.
  Gas consumption: ... 18
    wells ... 27
      records ... 48
  Population ... 18
Estlin, E. S. ... 5
Euphemia tp.
  Gas consumption: population .. 18
    wells ... 27
Eureka Oil and Gas Co. ... 73

Factories.
  Gas for, statistics ... 20, 21
Featherstone, C. W. ... 24
Fisherville Gas Co. ... 25
Flamboro tps.
  Gas consumption ... 19
    wells ... 27
      records ... 62
  Population ... 19
Fonthill.
  Gas consumption: population ... 17
    supply ... 2
Ford ... 17
Fort Erie.
  Gas consumption: population ... 17
    for industries ... 20
Free consumers of gas ... 18, 19
Frontier Oil and Gas Co. ... 26

Gainsboro tp.
  Gas consumption: population .. 19
    wells ... 27

PAGE
Galt.
  Gas consumption: population 17
    for industries 20
Gas and Oil Co., of Springvale 25
Gas burners. *See* Burners.
Gas engines.
    Gas for, statistics 20, 21
Gas stoves. *See* Stoves.
Gasoline.
  Compared with natural gas 32
Glanford tp.
  Gas consumption: population 19
    wells 27
Glencoe oil field. *See* Mosa tp.
Glenwood Natural Gas Co. 23-26, 48
Gosfield tps.
  Boring records 48
  Gas consumption: population 18
    wells 27
Grantham tp.
  Gas consumption: population 19
Grey co., boring records 68
Grimsby tp.
  Gas consumption: population 19

Hagersville 17
Hamilton.
  Gas consumption: population 17
    for industries 20
    peak load 13
    pressure 9
Haldimand co.
  Gas consumption: population 19
    wells 27
      records 50-61
Hamaker, Wesley 66, 67
Hamilton Gas and Oil Co. 23
Harwich tp.
  Gas consumption: population 18
  Oil, boring for 74
Hendee Gas Co. 23
Henderson, Geo. F. 3
Henderson, R. L. 74
Hepworth 17
Highgate.
  Gas consumption: population 17
    for industries 20
High Grade Natural Gas Co. 25
Hoover, A. E. 68
Hoover and May 24, 61
Houghton tp.
  Gas consumption: population 18
    wells 27
Howard tp.
  Gas consumption: population 18
Humber, A. 39, 40
Humberstone 17
Humberstone tp.
  Gas consumption: population 19
    wells 27
Hussey, W. J. 45
Hutton, John L. 73
Hyett and Johnson 74

Imperial Oil Co.
  Acknowledgments 48
  License 24
  Oil refining 76

PAGE
Industrial gas consumers, statistics 17, 18, 20, 21
Industrial Natural Gas Co. 23-26
Ingersoll.
  Gas, consumption: population 17
    for industries 20
Ingersoll Gas Light Co. 25
Inland Oil and Gas Co. 26, 73
Iron sulphate.
  Removal of, from gas 15
Irvine, J. J. 26

Jarvis.
  Gas consumption: population 17
    for industries 20
Jasperson, Bon 23, 24, 26, 28, 48
Johnson and Hyett 74

Kenney, John 49
Kent co.
  See also Kent gas field.
  Gas consumption 18
    price 22
    wells 27
      records 38-47
  Oil, boring for 74
  Population 18
Kent gas field.
  Report by Wyer 29-34
      ref to 2
  Volume; pressure: consumption 7,8
Kerlin, R. G. 2, 25
Kerosene.
  Compared with natural gas 32
Kerwood 74
Keyser, Bert L. 26, 74
Keyser Corners 74
King, Geo. 70
Kingsville.
  Gas consumption: population 17
    for industries 20
    meter, orifice 4
Kiser and Louer 24, 66, 69, 70

Lake Erie.
  Gas wells 36, 37
Lake Shore Natural Gas Co. 25
Lakeview 28
Lalor and Vokes 23
Lamb, A. 23
Lambton co.
  Gas consumption: 18
    wells 27
  Oil 72, 73
  Population 18
Leakage notes 14, 15
Leamington.
  Gas consumption 14, 17
    peak load, graph *facing* 14
    pressure 10
  License to town 25
  Population 17
Lever farm 68
Lincoln co.
  Gas, consumption: population 19
    wells 27

PAGE

- Lindsay, Ernest 36
- Logs of wells. *See* Boring for gas.

- McCarthy, C. M. 74
- McCutcheon, T. L. 24
- McCutcheon, T. J. M. 57, 60
- McDonald, W. H. 68
- McKecknie, Sam 24
- McKillop, Wm. 24, 62, 66
- McLister, J. J. 24, 58, 59
- Maidstone tp.
  - Gas, consumption: population 18
- Malahide tp.
  - Gas, consumption 18
    - wells 27
      - records 69, 70
  - Population 18
- Manitoulin island 74
- Manufacturers Gas Co. 25
- Map, oil field. *facing* 75
- Maple Leaf Oil and Gas Co. 26
- Marshall, James 23
- Mattagami river 74
- Medina Natural Gas Co. 23
- Melancthon tp. 69
- Merritton 17
- Mersea tps.
  - Gas, consumption 18
    - wells 27
      - records 48
  - Population 18
- Meters.
  - Orifice, notes and photo 4, 5
- Middleton tp.
  - Gas, consumption: population 18
    - wells 27
      - records 67
- Middlesex co.
  - Gas, consumption: 18
    - wells 27
      - records 70, 71
  - Oil, boring for 74
  - Population 18
- Midland Natural Gas Co. 23, 25
- Milkins, H. R. Jr. 26
- Mills, Hon. Henry 29
- Minor, L. E. 26
- Moore tp.
  - Gas, consumption: population 18
  - Oil; boring for; production 72, 73
- Mosa tp.
  - Oil; boring for; production 72, 73
- Moulton tp.
  - Gas, consumption 19
    - wells 27
      - records 56-61
  - Population 19
- Muirkirk 20

- National Gas Co. 23
- Natural gas. *See also* Boring for gas.
  - Measurement of 4
  - Production
  - Shortage 1, 2
  - Substitutes for 32
  - Supply, notes 7
- Natural Gas Commissioner 2, 3

PAGE

- Natural Gas Conservation Act 27
- Niagara Falls.
  - Gas consumption: population 17
    - for factories 20
- Nissouri tps. 27
- Norfolk co.
  - Gas, consumption 18
    - wells 19, 21, 27
      - records 66, 67
- Northern Gas and Gasoline Co. 23, 25
- Northern Pipe Line Co. 25
- North Shore Gas Co. 23

- Ohio State University.
  - Notes by, on economy in using gas 5-7
- Oil.
  - Gas an incident of prospecting for 30
  - Report 72-76
- Oil Springs.
  - Gas consumption: population 17
    - for industries 20
  - Oil production 72, 73
- Oil Springs Oil and Gas Co. 23, 25
- Oneida tp.
  - Gas, consumption 19
    - wells 27
      - records
  - Population 19
- Onondaga tp.
  - Gas, consumption; population 18
    - wells 27
  - Oil production 72, 73
- Ontario Gypsum Co. 23
- Open (Natural) flow.
  - Notes by Wyer 29
- Operators in natural gas.
  - List of, licensed 23-25
- Orford tp.
  - Gas, consumption; population 18
- Orifice meters.
  - Notes and photo 4, 5
- Oxford co.
  - Gas, consumption: population 18
- Oxford tp.
  - Gas, consumption: population 18

- Paris.
  - Gas consumption: population 17
    - for industries 20
- Peak loads.
  - Cities and towns 13, 14
  - Effects, notes and diagrams 8-13
- Peel co., boring records 69
- Pelham.
  - Gas, consumption: population 19
- Pelham tp. gas supply 2
- Pens Oil and Gas Co. 73
- Percentage contracts.
  - Abolition advisable 3, 29, 32
  - Explanation of term 31
- Petrol Oil and Gas Co. 23, 26
- Petrolia.
  - Gas for industries 20
- Petrolia oil field 72, 73
- Petrolia Utilities Co. 25
- Pickering, James 69
- Pilkington Bros. 23, 26

Page
Plympton tp. 72, 73
Point Abino 28
Population.
  Counties and townships 18, 19
  Towns and cities 17
Port Alma.
  Gas well opposite, notes and photo 36, 37
Port Colborne.
  Gas, consumption: population 17
    for industries 20
Port Colborne-Welland Natural Gas Co. 23, 25
Port Dover.
  Gas, consumption: population 17
    for industries 20
Port Rowan 17
Prairie Siding 20
Pressure of gas.
  Lowering recommended 33
  Various cities, diagrams 9-12
Putnam 21
Price of natural gas.
  Average retail 16
  Localities in gas district 17-19
  Notes by Wyer 34
  Ratio of, to gas consumed 22
Price of oil 72
Provincial Gas and Oil Co. 26
Provincial Natural Gas and Fuel Co.
  Appeal to adjust prices 3
  Boring at Point Abino 28
  Licenses to 23-26

Quillinan, J. A. 26

Rainham tp.
  Gas, consumption: population 19
    wells 27
Raleigh tp.
  Gas, consumption 18
    wells 27
      records 39-41, 45, 46
  Oil 72, 73
  Population 18
Randall, A. E. 39, 47
Rate of gas flow.
  Various cities, diagrams 9-12
Referee.
  Appointment of, and powers 27, 28
Refining operations, oil 76
Relief Gas Co. 2
Richmond Gas Co. 23
Ridgetown.
  Gas consumption: population 17
    for industries 21
Ridgeway 21
Roberts, C. C. 75
Robnett, C. W. 26
Rochester tp.
  Gas consumption: population 18
Rock pressure.
  Kent field, graphs 8, 31
  Notes by Wyer 29
Rodney.
  Gas consumption: population 17
    for industries 21

Page
Romney.
  Gas, consumption: population 17
  Wells drilled 27
Rosehill Natural Gas Co. 25
Rowe, E. P. 74
Rowe, S. P. 44

St. Catharines.
  Gas, consumption: population 17
    for industries 21
    peak load, graph *facing* 14
    rate of flow, diagrams 12
St. George 17
St. Vincent tp. 68
Sandwich 21
Sandwich tps.
  Gas consumption: population 18
Sarnia.
  Gas consumption 17
    for industries 21
    pressure to graph 13
    shortage 1-3
  Population 17
Sarnia tp.
  Gas consumption 18
    new field 28
    wells 27
  Oil production 72, 73
  Population 18
Sarnia Gas Co. 25
Saul farm 71
Scott, John 72
Sediment trap.
  For removing iron sulphate from gas, notes and photo 15
Selkirk 21
Seneca tp.
  Gas, consumption 19
    wells 27
      records 50-57
Shedden-Fingal 21
Shelburne 74
Sherbrooke tp.
  Gas consumption: population 19
    wells 27
Shetland Gas Co. 25
Simcoe.
  Gas consumption: population 17
    for industries 21
Smith, H. B. 26
Smith, R. H. 26
Snively, F. L. 24, 26, 56-65, 71
Sombra tp.
  Gas consumption: population 18
Southern Ontario Gas Co.
  Appeal to adjust prices 3
  Licenses to 24, 25
Southwold tp.
  Gas consumption: population 18
Sparham, A. F. 23
Staehling, E. H. 26
Stamford tp.
  Gas consumption: population 19
Sterling Natural Gas Co. 23, 25
Stevensville 21
Stevensville Gas Co. 23
Stover, F. H. 24

PAGE
Stover Drilling Co. 45
Stoves for "sulphur" gas 7
Stroup, John 38, 44, 46
Substitutes for natural gas 32
"Sulphur gas."
  Notes by Wyer 30
  Special stove for burning 7
Sundy Gas Well Co. 23
Symmes, H. D. 26

Tecumseh 17
Thames Oil and Gas Co. 26
Thamesville oil field 72, 73
Thorold.
  Gas, consumption: population 17
    for industries 21
Thorold tp.
  Gas consumption: population 19
Tilbury.
  Gas consumption: population 17
    for industries 21
Tilbury tps.
  Gas consumption 18
    meters, orifice 4
    wells 27
      records 38, 41-43, 46, 47
    See also Port Alma.
  Oil production 72, 73
  Population 18
Tillsonburg.
  Gas consumption: population 17
    for industries 21
Toronto 8
Toronto tp., boring record 68
Tupperville 17

Union Exploration Co. 24, 26, 29
Union Natural Gas Co.
  Appeal to adjust prices 3
  Licenses to 23-25
  Wells sunk by 41-43
    in Dawn tp. 28
United Gas and Fuel Co. 25
United Gas Companies, Ltd. 23-25
Universal Gas and Oil Co. 24, 26

Vacuum Oil and Gas Co. 23
Valley Oil and Gas Co.
  Boring at Dundas and Copetown 28, 74
  Licenses to 26
Vienna 17

Waddell, J. C. 73
Wainfleet tp.
  Gas consumption: population 19
    wells 27
Walkerville.
  Gas consumption: population 17
    for industries 21
Wallaceburg.
  Gas consumption: population 17
    for industries 21
Wallaceburg Gas Co. 4, 25

PAGE
Wallacetown 21
Walpole tp.
  Gas consumption 19
    wells 27
      records 50, 57, 58
  Population 9
Walsingham tp.
  Gas consumption: population 18
    wells 27
      records 66, 87
Waste of gas
  Notes by Wyer 30, 31
  Rules to prevent 33
Welland.
  Gas consumption: population 17
    industries 21
Welland co.
  Gas consumption 19
    wells 27
      records 49
  Population 19
Wellandport 21
Wells.
  List of, 1921 27
  See also Boring for gas.
Wentworth co.
  Gas consumption: population 19
    well records 62-66
Western Counties Gas Co. 26
West Lorne.
  Gas consumption: population 17
    for industries 21
Wheatley 17
Wiles, Charles H. 26
Williams, A. 26
Williams, M. Y. 72
Willoughby tp.
  Gas consumption: population 19
    wells 27
Windham tp.
  Gas consumption: population 18
    wells drilled 27
Windsor.
  Gas consumption: population 17
    for industries 21
    meter, orifice 4, 5
    pressure, graphs 9, *facing* 14
    shortage 1-3
Windsor Gas Co. 25
Winger, S. W. 26
Wolfe, E. 40, 41
Woodhouse tp.
  Gas consumption: population 18
    wells 27
      records 66, 67
Woodstock.
  Gas consumption: population 17
    for industries 21
Woodstock Gas Light Co. 25
Wyer, Samuel S.
  Report by, on Kent gas field 2, 29-34

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES — THOS. W. GIBSON, DEPUTY MINISTER

THIRTY-FIRST ANNUAL REPORT
OF THE

ONTARIO DEPARTMENT OF MINES

BEING
VOL. XXXI, PART VI,
1922

Geology and Minerals
OF THE
COUNTY of LEEDS

By
M. B. Baker

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed by CLARKSON W. JAMES, Printer to the King's Most Excellent Majesty
1923

Printed by
THE RYERSON PRESS

CONTENTS

Vol. XXXI, Part VI.

PAGE.

Introduction 1

Topography 2

Age classification of the rocks of the area 2

Grenville 3

  Crystalline Limestone 3

  Quartzite 4

  Gneisses 6

  Breccia 6

Laurentian 7

  Mica and Phosphate 9

Algoman 10

PAGE

  Pegmatite dikes 11

  Feldspar 12

  Granite for Building Uses 13

Keweenawan 14

  Nickel and Iron Ore 15

Cambrian 16

  Iron Ores 16

  Building Stone 17

  Sandstone for glass-making ... 18

Ordovician 20

Glaciation and its effects 20

Summary of Economic Minerals ... 23

ILLUSTRATIONS

PAGE

Frontispiece .... *facing* 1

Fig. 1—Grenville crystalline limestone, showing original bedding preserved 4

Fig. 2—Grenville quartzite in perfect conformity with crystalline limestone 5

Fig. 3—Pseudo-conglomerate of fragments of paragneiss in matrix of crystalline limestone 7

Fig. 4—Grenville gneiss, showing prominent *lit-par-lit* intrusions of Laurentian.. 8

Fig. 5—Algoman pegmatite dike which cuts Algoman granite, Washburn 11

Fig. 6—Lyndhurst Granite Quarries, showing perfect jointing of the Algoman granite 13

Fig. 7—Joint blocks of Algoman granite from the quarries of A. C. Brown, Lyndhurst 14

Fig. 8—Grenville limestone and Algoman pegmatite, both cut by dike of Keweenawan trap 15

Fig. 9—Cliff-like front of Potsdam sandstone with conglomerate at base, resting on Grenville gneiss floor 16

Fig. 10—Contact of Black River limestone with Algoman granite 17

GEOLOGICALLY COLOURED MAP

No. 31c.—Leeds County, scale 2 miles to the inch. (*In pocket inside back cover.*)

Great War Veterans' Memorial at Lyndhurst, Leeds county. The Algoman granite from which the monument was cut came from the local quarry of A. C. Brown.

GEOLOGY AND MINERALS OF THE COUNTY OF LEEDS

By M. B. Baker

Introduction

Accompanying the report of the Royal Commission on the Mineral Resources of Ontario (1890) is a small scale map prepared from the various Dominion surveys made between the years 1842 and 1882. In the vicinity of the Thousand Islands this map shows the Paleozoic sediments lying against the pre-Cambrian complex, but the latter is shown merely under the old classification of Laurentian and Huronian.

In 1901 the Geological Survey of Canada issued a report[1] along with a map showing portions of the counties of Frontenac, Renfrew, Lanark, and Leeds. This map also outlines the Paleozoic and pre-Cambrian in much more detail, but no attempt is made to subdivide the pre-Cambrian, and it is therefore shown in one colour. The map shows that between Kingston on the west, and Brockville on the east, is a belt of pre-Cambrian rocks, which like an isthmus joins two very large areas of similar character, one to the northwest in eastern Ontario, and the other to the southeast in the State of New York, U.S.A.

In 1910 there was issued by the New York State Museum, Bulletin No. 145 "On the Geology of the Thousand Island Region," with a detailed description, and an excellent geological map of New York State. References were made to the probable continuation of some of these formations into Canadian territory. Thus it seemed advisable to have the area in Ontario immediately adjoining the boundary line, geologically surveyed, especially as the geology of this area is typical of a much larger one, which yields excellent economic deposits of mica, talc, phosphate, feldspar, quartz, and many other minerals. In 1916 the writer made a geological report with a map of the south part of Frontenac county for the Bureau of Mines.[2] The present report and map should be examined in conjunction with those of 1916, as the two are contiguous and together cover the geology of the area between Kingston and Brockville, about the Thousand Islands, and for a distance of approximately thirty miles north of the International boundary line.

The production of the map was supervised by W. R. Rogers, topographer of the Department of Mines, to whom the writer tenders his thanks.

Contoured roads maps issued by the Military Surveys Branch of the Department of Militia and Defence, Ottawa, were used as a base for the work in the south and east parts of the country. The Ontario Department of Highways supplied the base map for the balance of the area covered.

---

[1] Geol. Sur. Can., Vol. XII, Pt. 1. Iron Ore Deposits along the Kingston and Pembroke Railway, by E. D. Ingall.

[2] Ont. Bur. Mines, Vol. XXV, 1916, Pt. III. The Geology of Kingston and vicinity. By M. B. Baker.

Topography

The general topography of this area is that characteristic of pre-Cambrian formations occupying the eastern portion of Canada. The whole area represents a very ancient peneplain, the result of long periods of erosion, in which all prominences have been pretty well removed. The rocks making up the area are almost all metamorphosed, so that their schistose and gneissic structures have formed lines of weakness, along which erosion took place more readily than it did across the structure. The result has been a series of ridges and hollows whose longer axes lie northeast and southwest.

Differences in hardness of the rocks has given rise to a series of ridges and hollows, which correspond in direction with the general gneissic structure. The most pronounced hollows, usually occupied by lakes, are formed where the rocks were crystalline limestone, while the ridges forming the watersheds between the lakes and drainage channels are composed of the most resistant rocks, for example, granite gneisses or other metamorphosed igneous rocks.

Recent glaciation has refreshed this topography merely, but not produced it, for an examination of the area clearly shows that the present contour was developed before the Cambrian sediments were laid upon it. In many places thin outliers of Cambrian sediments still remain, and beneath these the old topography of pre-Cambrian rocks can be clearly seen. It differs in no way from the exposed portions, and shows plainly that the topography of the pre-Cambrian areas was developed in pre-Cambrian times. While locally it is very rough, being made up of mounds and hollows, swamps, lakes, and river valleys, there are no great contrasts in altitude. All the ridges are of about equal height, approximately 650 feet above the sea, so that the whole area presents an even sky-line, when viewed from the top of any one mound or ridge.

Age Classification of the Rocks of the Area

Below is the classification of the rocks, according to their age relations, used in this report and on the accompanying map. The oldest rocks are at the bottom of the table.

PLEISTOCENE	RECENT		Marl and peat beds, shallow water deposits, and sand dunes.
	GLACIAL		Laminated clays, sand and fine gravel; all sorted products of glacial till. Boulder clay, unsorted glacial till.
PALEOZOIC	ORDOVICIAN	Black River—	Leray and Lowville—coarse limestones. Pamelia formation—a fine-textured limestone. Rideau beds (basal member of Pamelia), shales, sandy limestones and conglomerates.
	CAMBRIAN	Potsdam—	Sandstones.

		GREAT UNCONFORMITY.
PRE-CAMBRIAN	KEWEENAWAN..	Trap, diabase and gabbro intrusives.
		INTRUSIVE CONTACT.
	ALGOMAN........	Coarse-grained granite and syenite intrusives, with later pegmatites.
		INTRUSIVE CONTACT
	LAURENTIAN....	Grey to pink, medium to fine-grained, granitic gneisses.
		INTRUSIVE CONTACT
	GRENVILLE	White, coarsely crystalline limestone, with quartzite and rusty-weathering gneisses.
		Dark green to black gneisses, thoroughly impregnated with minute dikes of Laurentian granite, now also changed to gneiss.

Grenville

The earliest members of the geological record have been the subject of intensive study, re-grouping, and re-classification by many geologists. It is doubtful if any other group of rocks has received so much attention. The earliest geologists claimed that the pre-Cambrian was almost entirely a group of igneous rocks, in most complex relationship, and it was only in recent years that any appreciable amount of sedimentary material has been admitted to the pre-Algoman complex. It is now well established that a large part of the oldest formations yet discovered are sediments, and the Grenville is becoming a more comprehensive group than formerly.

In 1907 a paper[1] was written on "The Grenville-Hastings Unconformity" by W. G. Miller and C. W. Knight, in which they stated that a sedimentary series, which they called the Grenville, rested on an older floor of basic lavas, which they called the Keewatin. The Keewatin is therefore the oldest formation yet discovered in Ontario, and is entirely igneous in origin, and composed largely of basic lava flows. The Grenville, on the contrary, is almost entirely sedimentary in origin, a part being chemically deposited, and lies for the most part upon the Keewatin. Some of the beds are interlaid with the later Keewatin flows in much the same manner as are the Keweenawan sediments and volcanic flows of Keweenaw Point on Lake Superior.

In northwestern Ontario the Keewatin is abundantly present and the Grenville rather scarce. In southeastern Ontario, on the contrary, the Keewatin is practically wanting, while the Grenville is abundant. A glance at the map accompanying the report on the Kingston area[2] and the map accompanying this report brings this fact out very prominently. No recognizable Keewatin was seen in either area examined by the writer, but large areas of Grenville sediment are indicated.

Crystalline Limestone

The most easily recognized member of the Grenville series is crystalline limestone, but closely associated with this are quartzites, rusty-weathering gneisses, and dark green to black micaceous, hornblende, or garnetiferous gneisses and schists. The limestones are as a rule coarsely crystalline, the individual grains being frequently as large as peas. They are rather pure as a whole, but in many places contain flake graphite, phlogopite, hematite, chondrodite, vesuvianite, diopside, quartz, and other minerals. Their softer character has rendered them more susceptible to erosion than the accompanying rocks, so that they occupy the basins of the various lakes of the area, and are also the valley bottoms of many of the northeast-southwest drainage channels. This is a very pronounced feature of the area, and is well brought out on the accompanying map. The section which accompanies the map, and which cuts across the strikes of the rocks, shows well the depressed portions of Grenville limestone, due to its rapid erosion, as compared with the more resistant areas of Algoman granite, or Grenville and Laurentian gneisses.

---

[1] Ont. Bur. Mines, Vol. XVI, 1907, Pt. 1. Page 221.
[2] Idem, Vol. XXV, 1916, Pt. III.

The original bedding of the limestones can still be seen in many places, and shows the series to be standing at high angles from 40 to 65 degrees, Fig. 1.

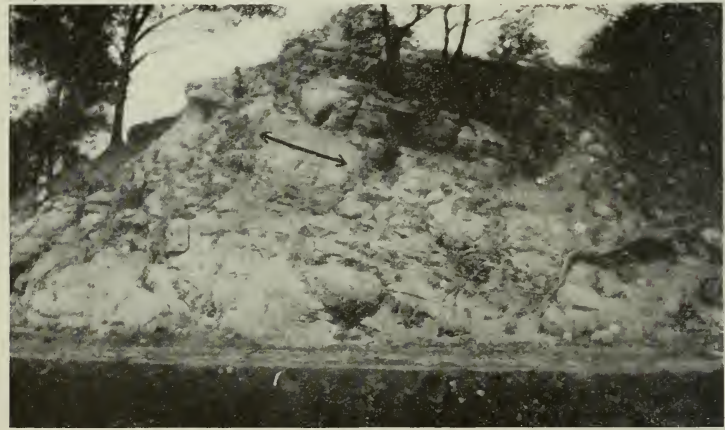


Fig. 1.—Grenville crystalline limestone, showing original bedding preserved.

The constancy of strike in this series, and the pronounced isoclinal dip of most cross-sections, have led to numerous discussions as to the total thickness of these sedimentary beds. The writer attempted to work out the structure from the crystalline belts, but found the dips so variable that he was unable to do this satisfactorily. It would appear, however, that the great belts of gneiss, crystalline limestone, and quartzite shown on the accompanying map are due to repeated isoclinal folding of the Grenville series, and do not indicate the enormous thickness of original sediments asserted by some investigators. Even this conception means that each of these belts would represent a series of great thickness, tilted up at a high angle.

Quartzite

The Grenville quartzite is a compact greenish to white rock, often showing the distinct banding or bedding of the original sandstone from which it was formed, Fig. 2. The masses are so dense and hard that they form very prominent features in the landscape, usually standing up as distinct ridges with their long axes running northeast and southwest, while softer members of the Grenville series occur in parallel hollows and valleys. In many places the quartzite is in contact with the crystalline limestone, and small bands of quartzite from two to ten inches thick are interlaminated with the limestone.

Analysis of this quartzite is given below:

	Per cent.
SiO_2	98.14
CaO	.35
Al_2O_3	.88
Fe_2O_3	.41
	99.78

This quartzite would be suitable for the manufacture of silica refractories, e.g. silica brick, but it is not suitable for glass manufacture on account of the crushing which it requires, and which would give a very high percentage of angular fines.

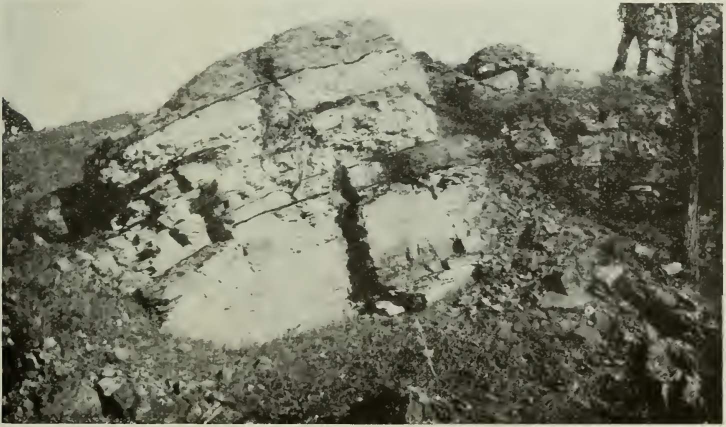


Fig. 2.—Grenville quartzite in perfect conformity with crystalline limestone, showing original bedding of both and the superior hardness of quartzite.

In examining any unmetamorphosed section of sedimentary rocks the outstanding features will admittedly be the prominent bedding planes; the continuity of composition and texture along the bedding; and the abrupt and numerous changes in composition and texture across their bedding. Keeping these features in mind, one would expect that a metamorphosed series of sedimentary rocks would show, in addition to the gneissic or schistose structure, a marked banding or belting in the direction of the original bedding, and a variety of colours and textures in the several bands, depending on their changing composition, across the former bedding. This is a feature of the Grenville series that cannot be too much emphasized.

Gneisses

Great belts or zones of rusty-weathering gneisses, together with green to black micaceous, hornblendic, or garnetiferous gneisses are to be found throughout the area under consideration. They are shown on the map in blue coloration, and their pronounced northeasterly extension is very evident. They are closely inter-belted with bands of crystalline limestone or with quartzite. The rusty-weathering effect is due to the oxidation of pyrites, which most of them contain in scattered grains. The most prominent feature of these gneisses is their pronounced platy cleavage in addition to the gneissic texture. Usually this platy cleavage corresponds in direction with the gneissic texture. and also with the dip and strike of the accompanying crystalline limestone belts.

Chemical analysis of highly metamorphosed rock is of value in determining the origin of the series, especially when taken in conjuction with field relationships. Samples of these gneisses were therefore selected and the analyses are shown below.[1]

SiO_2	Al_2O_3	Fe_2O_3	Ca O	Mg O	K_2O	Na_2O	CO_2	X O	Total
45.14	11.20	2.40	20.42	3.26	3.86	2.90	10.08	....	99.26
48.34	12.71	5.43	19.85	1.66	2.51	2.64	2.90	3.92	99.52
59.08	13.90	3.30	10.68	3.50	4.23	1.61	1.05	3.40	100.75

The writer has already stated his doubt as to the value of chemical analyses of highly metamorphosed rock, but considered in the light of field relationships, distribution, and geological form of occurrence, rock analyses certainly offer evidence of reliable and confirmatory value. The low percentage of silica and potash might suggest a basic igneous rock, but the accompanying low percentage of ferro-magnesian constituents preclude this possibility. The rather high percentage of alumina and calcium carbonate confirm the claim for a highly calcareous set of sediments, accompanying the crystalline limestones and quartzites. From the field relationships and the analyses it is probable that the rusty-weathering gneisses represent sandy sediments which were originally present with the limestone, and which suffered metamorphism along with it, in order to produce the gneissic characters now shown.

Breccia

A very frequent occurrence in the area is a pseudo-agglomerate or breccia, made up of fragments of gneiss in a matrix of crystalline limestone. In many cases the fragments of gneiss are in alignment, or carry out a warp or curve indicating a flow-like structure. Fig. 3. They undoubtedly represent the more resistant, brittle fragments of the paragneisses that have been mashed up with the crystalline limestone when undergoing deformation. The limestone being so much softer, simply mashed up and flowed about the brecciated gneiss. This is a very striking rock, and is abundant throughout the area. It forms one more proof that the belted gneisses, accompanying the crystalline limestone, are of sedimentary origin, and were clayey to sandy impure sediments of Grenville age, which suffered metamorphism along with the purer limestones and sandstones to form the highly complicated and intimately mixed group now known as the Grenville series.

---

[1]Analyses by W. K. McNeill, Provincial Assayer, Toronto.

In addition to the calcareous group just described and mapped in blue colour, there are many other areas of micaceous and hornblendic gneisses in parallel position with the calcareous belts, but they lack the lenses of crystalline limestone. Their outstanding feature is their platy cleavage, in addition to the gneissic texture. They also are believed by the writer to be largely impure sediments, but he is unable to prove that they are not partly igneous in origin. They may represent a most intimate mixture of Grenville sediments with inter-laminated Laurentian intrusions in *lit-par-lit* injection. For this reason they are mapped in a different colour, green. In many places they resemble the gneissic parts of the typical Grenville, but in other places they are so characteristically granitic or syenitic, that their resemblance to the Laurentian is more striking. As they may be a mixture of the Grenville with the Laurentian, they are so mapped by the writer.

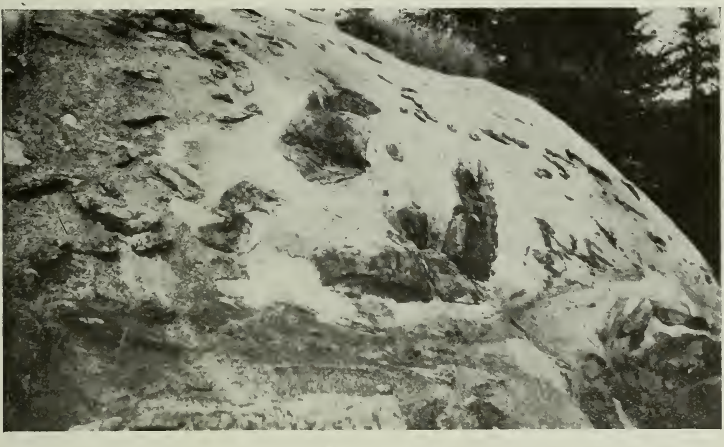


Fig. 3.—Pseudo-conglomerate of rusty-weathering fragments of paragneiss in a matrix of Grenville crystalline limestone.

Laurentian

The Laurentian has been defined by the International Committee on nomenclature as consisting of the great masses of gneissic granite that invade the Grenville series, and nothing younger.[1] It is essential that this point be insisted upon because another series of pink granites, often somewhat gneissic, invades the Grenville and also later formations, and it is only by stratigraphic field examination that these two can be definitely distinguished. The Laurentian is granitic for the most part, but also has syenitic phases. It is medium to fine-grained, pinkish to grey in colour, and always strongly gneissic in texture. A small amount of mica (biotite) is usually present, and this serves to bring out prominently the gneissic structure on weathered surfaces. There are three belts of predominantly Laurentian rocks, sufficiently large and free from accompanying Grenville material to show their real character, exposed in the area mapped. One of these extends from just east of Gananoque in a northeasterly direction along the river front to Yonge Mills. A second area is shown west of Newboro lake, while a third area, and much the most characteristic one, occupies all the northern part of the township of South Crosby. A chemical analysis by W. K. McNeill from the second of these areas mentioned shows it to be a typical granite converted into gneiss by metamorphism.

---

[1] Jour. Geol., Vol. XV, 1907, Page 216.

SiO_2	Al_2O_3	Fe O	Fe_2O_3	CaO	MgO	K_2O	Na_2O	X O	Total
64.45	14.11	0.10	8.96	tr	0.19	7.20	1.62	3.64	100.27

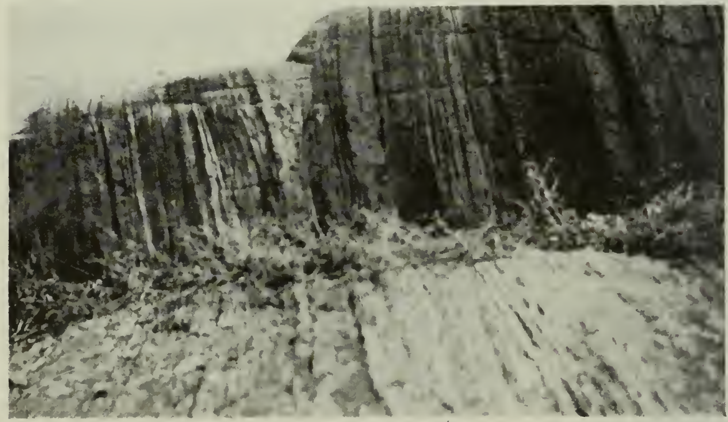


Fig. 4.—Grenville gneiss, showing prominent *lit-par-lit* intrusions of Laurentian.

In addition to the larger masses of Laurentian gneiss there are areas, as mentioned above under the discussion of the Grenville, which show a most intimate mixture of minute intrusive dikes of Laurentian rocks into the bedded Grenville sediment. They appear as abundant lens-like bands whose longer axes correspond to the gneissic and bedded direction of the sediments, Fig. 4.

A typical area of this kind extends from just north of Gananoque Junction northeasterly to Charleston lake. Another area is shown about Sand lake, just north of Jones Falls. Here excellent exposures of the crushed or mashed Grenville are seen where the intrusive Laurentian granite appears to have caused the crushing.

These minute dikes of Laurentian granite are so numerous that it is difficult to determine which formation predominates. It is therefore scarcely possible to decide whether the area should be mapped as Grenville or Laurentian. A mixed symbol has accordingly been used for them. In many places the alternate bands of Grenville and Laurentian gneisses are not over half an inch thick, and are repeated so often as to produce a most striking result. Many of the small Laurentian dikes jog across the bedding of the Grenville gneiss from layer to layer, so as to preclude the possibility of their being contemporaneous in age.

No close examination of the Grenville where it is intruded by large masses of Laurentian rock, can fail to emphasize the importance of the contact of these two. Almost everywhere that a large body of Laurentian intrudes a similar body of Grenville rocks, a zone of contact metamorphism is the result. Many contact minerals were generated, and some in such large quantities as to be of economic value. Two of these, apatite or calcium phosphate, and phlogopite or amber mica, have been largely mined; while a third mineral, calcite, or coarsely crystallized limestone, is now being mined and is finding a market in ground form in the manufacture of paints, and as a filler for paper.

Mica and Phosphate

Southeastern Ontario has long been known as an important producer of phlogopite or amber mica. In the "Geology of Canada," issued by the Geological Society in 1863, reference is made by Sir William Logan to the occurrence of mica in this area. He says, "it appears probable that by further exploration in this region and in Grenville, sufficient quantities of mica could be obtained to supply a large demand."

All early reports of mica occurrences speak of its association with phosphate, and in fact, the phosphate industry flourished long before the mining of mica was carried on. In 1868 apatite was mined by the Rideau Mining Company in North Burgess township, and was shipped to Germany. It then brought seven dollars per ton. In 1871 apatite was discovered in the township of Loughborough by H. G. Vennor. Mica then began to be mined as a by-product in the phosphate industry. It was not, however, until after 1890 that there was any appreciable demand for mica. Of the great quantity that had been mined in the phosphate industry, and thrown on the dumps, only a very small portion of the choicest sizes found a market.

After 1890 both mica and phosphate found sale for a time, but the placing of the easily mined phosphates of the southern states on the market, soon stopped the sale of the harder and more costly phosphate of southeastern Ontario. A demand for this phosphate is being revived, however, and the Chemical Products Limited of Trenton, Ontario, is now in the market to purchase a supply. It is not the writer's intention to deal in detail with the mica industry. Monograph No. 118 on mica, issued in 1912 by the Mines Branch, Department of Mines, Ottawa, is full of information for those who wish particulars. Suffice it to say that along the contact of the Laurentian intrusives with the highly calcareous Grenville formation were developed scattered crystals of pyroxene, phlogopite, apatite, calcite, scapolite, graphite, and other minerals, showing clearly that these minerals were brought into being as contact metamorphic crystallizations, and were the result of a siliceous magma coming in contact with a dolomitic country rock.

In many cases the contact produced a rather fine-grained crystalline rock composed largely of pyroxene, mica, and apatite, which may easily be taken for a pyroxenite, and from its position would appear to be intrusive, as has been so frequently claimed. At other places more open and spacious contacts developed larger crystals, and it is from these that the merchantable mica and apatite are got. Pyroxene crystals six inches square, apatite crystals up to ten inches in diameter, sphene four inches across, and zircons half an inch to a side and an inch and a half in length, and other crystals of similar dimensions have made these localities famous as collecting grounds for the mineralogist. The writer would therefore advise prospectors for mica, to search out contacts of Grenville sediments (mapped in blue colour) with Laurentian gneisses (mapped in green) and follow these contacts for the location of economic deposits. That the granitic intrusion which caused the metamorphism and mineralization, was Laurentian in age, and not Algoman, is certain, because both Algoman and later rocks cut these mica-phosphate deposits.

Algoman

In their work in southeastern Ontario, Miller and Knight showed that a series of intrusive granites and syenites cut the Hastings group, which they considered the equivalent of the Timiskaming series.[1] These intrusives are called Algoman. The writer cannot prove that the igneous masses which he has placed in the Algoman are post-Timiskaming, but they are clearly later than the Laurentian, for they cut it, and since they correspond in every other respect with the post-Timiskaming intrusives of the area lying immediately to the northwest, and described by Miller and Knight, he believes them to be identical in age, i.e., Algoman.

Similar occurrences are found in the Thousand Islands region described by Cushing in his report of that area.[2] Regarding these rocks Cushing says:—

> This (Picton granite) is the latest, most extensive, most interesting, and most extensively quarried. . . . . . Across the border in Canada, it seems to have large extent, though it has not yet been differentiated from the Laurentian in mapping. If, however, we are correct in correlating the granite at Kingston, Ontario, with this rock, a batholith of considerable extent is implied. The general rock is rather a bright red granite of quite coarse grain. It varies much in this respect, however, and much of the border rock is of much finer grain. Red feldspars constitute 75 per cent. or more of the rock. Considerable quartz is usually present, and is frequently characterized by a slightly bluish cast, which makes a helpful diagnostic feature of the rock. Hornblende and biotite are sufficiently abundant to show prominent black spots in the otherwise red rock. In all likelihood the rock can be carried across on the Canadian islands to the mainland, and thence west to Kingston, but until this has been done some reserve must be felt in making the correlation.

A casual examination of these later granites, syenites, and their accompanying dikes, causes one to hesitate in attempting to distinguish them from typical Laurentian members which they so closely resemble. Where the Timiskaming series is present the age of these granites and syenites is of course readily determined. Even where no Timiskaming is present by which to fix the ages of the Algoman, a close examination brings out the following characteristics:—The rock is coarser-grained than the Laurentian, and is composed of pink orthoclase and microcline feldspars, with quartz bluish to milky coloured instead of clear, glassy, and colourless. Biotite and hornblende are often present, but occur in larger grains and are not so abundant as in the Laurentian members. The rocks are distinctly redder in general appearance, noticeably fresher and undecomposed. They are very much less gneissoid than the Laurentian; in fact, most of the granites and syenites of Algoman age show no gneissic structures at all, and are typical medium- to coarse-grained, plutonic crystallizations.

---

[1] Ont. Bur. Mines, Vol. XXII., 1913, Pt. II. P. 130.

[2] New York State Museum Bulletin 145.

A gneissic structure is, however, often shown fairly well developed along the margins of the mass, but even here such structure is indicated rather by the drawn-out character or alignment of the dark minerals, than by the crushed and dynamically squeezed appearance of typically Laurentian gneisses. This alignment of dark constituents in the Algoman borders appears to be due more to a flow structure produced while the mass was still potentially liquid, by a rubbing or flow along its margins, than to true gneissosity due to subsequent dynamic forces. From these main differences it is possible to distinguish with a great degree of certainty between Laurentian gneisses and the much later Algoman granites and syenites, even when these are gneissic in structure.

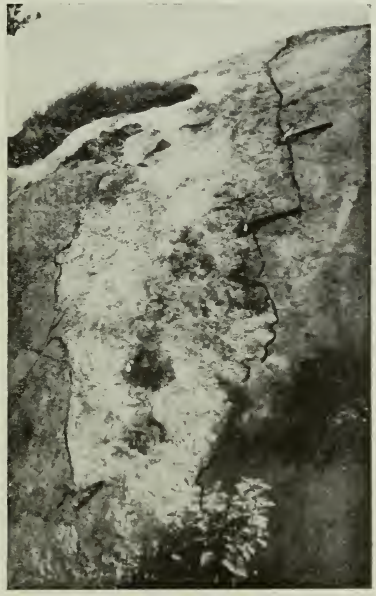


Fig. 5.—Algoman pegmatite dike which cuts Algoman granite, Washburn, Rideau canal.

Pegmatite Dikes

As a final phase of the Algoman intrusion, and after it had cooled sufficiently to be jointed and fractured, came a series of pegmatite dikes, which showed a considerable tendency to differentiate, Fig. 5; so much so, that large economic deposits of feldspar, and of quartz have resulted in many cases. This feldspar is pink in colour and is largely microcline; at other times it is an intimate mixture of orthoclase and microcline, in microperthitic texture. The quartz of the pegmatites is also in sufficiently large masses to be mined separately, and used in the manufacture of ferro-silicon bronze, and in other industries requiring silica.

Where these Algoman pegmatite dikes cut Grenville or Laurentian gneisses, they form coarse-textured, pink-coloured dikes whose feldspar is rich in potash, running usually 13 per cent. On the other hand, where these dikes cut Grenville crystalline limestone, they yield white or bleached-looking pegmatites, composed of pale, white feldspars carrying about 6 per cent. of potash and 3 per cent. of soda. In these white pegmatites, moreover, there is not the same tendency to differentiation as in the pink ones, and in no deposit seen by the writer was the feldspar sufficiently free from quartz intergrowth to yield merchantable feldspar. Contemporaneous crystallization yielding graphic granite texture, seems to have been the rule in these dikes. Even fragments of apparently clear white feldspar, when examined under a microscope, show abundant micro-pegmatitic intergrowths of quartz.

Dr. Cushing, in his report on the Thousand Islands region, records similar effects where granitic dikes cut crystalline limestone. He adds the very interesting information that he discoloured the pink feldspars by heating them over an ordinary Bunsen burner in the presence of limestone.[1]

Feldspar

Feldspar in more or less pure form has been mined from the Algoman pegmatite dikes of eastern Ontario for twenty years. It is used chiefly in the glazing of electric insulators, reflectors, toilet and bath equipment, earthenware, china, decorative tile, etc. It is also used in finely ground form in the manufacture of the body of heavy insulators for hydro lines, all classes of common earthenware, and floor tile. For these purposes it is mixed with ground quartz and with a good quality of china clay. The moulded or dry-pressed article is fired to a solid porcelain-like body, and is later glazed or not as required.

It is to be noted that for glazing purposes the feldspar needs to be as pure as it is possible to get it, otherwise checks, blotches, flaws and discolorations appear. For the manufacture of earthenware or porcelain a certain percentage of quartz is not objectionable, for in any event quartz will be later added in the mix. The writer has mentioned above that two classes of Algoman pegmatite dikes occur. In one the ingredients are so well segregated or differentiated that clean feldspar can be obtained from them, such as is demanded by the glazing industry. In the other pegmatites it was pointed out that they took on a graphic granite texture where the quartz and feldspar are most intimately mixed. If the percentage of quartz is not too high, say over 15 per cent., these dikes can be used and cobbed to a saleable product for the porcelain, tile, or earthenware industry, but the material will not command so high a price. These two features should be clearly borne in mind in prospecting for feldspar, or in offering it for sale to the manufacturer. It should also be remembered that the presence of mica, hornblende, or tourmaline will condemn the product for either use, so that many otherwise promising feldspar deposits are useless on this account. These minerals cause flaws, uneven textures, and discolorations of the article, or of the glaze, as the case may be.

---

[1] New York State Bulletin No. 145, Page 179.

Granite for Building Uses

The Algoman masses of granite and syenite show jointing as a rule, and in many places the jointing is remarkably good, Figure 6, allowing the rock to be quarried into fine building blocks and monumental stones, while the smaller waste pieces are readily trimmed to paving blocks or cobble-stone. A promising industry is being built up in paving blocks, and also larger granite monumental or building-blocks in this vicinity. The Woodburn Granite Quarries, Gananoque, operated by Charles Gordon and associates, and the Lyndhurst Granite Quarries at Lyndhurst belonging to A. C. Brown, are the chief producers at present. These granites are being used also for polished and lettered monuments, and for red to pink granites the writer has no hesitation in recommending them as the equal of anything in colour and durability he has seen. A good example is seen in the Great War Veterans' memorial monument erected at Lyndhurst. (*See Frontispiece*). This stone was supplied from the quarries of A. C. Brown, situated near the western end of the large exposure of Algoman granite extending westward from the village of Lyndhurst to Whitefish lake, Figs. 6 and 7. Tombstone men will do well to look into this source of supply before going to the expense of importing red granites, that are in no way superior, but cost much more.

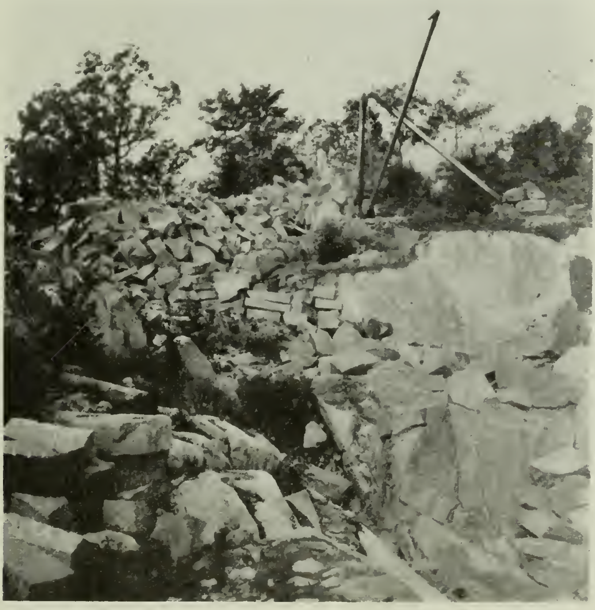


Fig. 6.—Quarries Lyndhurst Granite, showing perfect jointing of the Algoman granite.

Keweenawan

The youngest of the pre-Cambrian rocks in the county of Leeds is a group of diabases, traps and gabbro intrusives. These cut the Algoman as well as all earlier rocks. In other parts of Ontario a great series of sediments, which lie unconformably on the Algoman, and which are known as Animikie in age, are cut by a similar set of basic dikes and sills, and their age is therefore fixed. Since in this area no Animikie rocks are to be found, it can only be said that these later dikes are post-Algoman, but as was the case in considering the Algoman, the perfect similarity of material and structure seems to justify the correlation of these basic intrusives with the proven Keweenawan of other areas. The only alternative is to introduce other periods of igneous activity than those generally recognized throughout the pre-Cambrian rocks of Ontario, and this is much less justifiable than to correlate them with the already well-known and established periods.

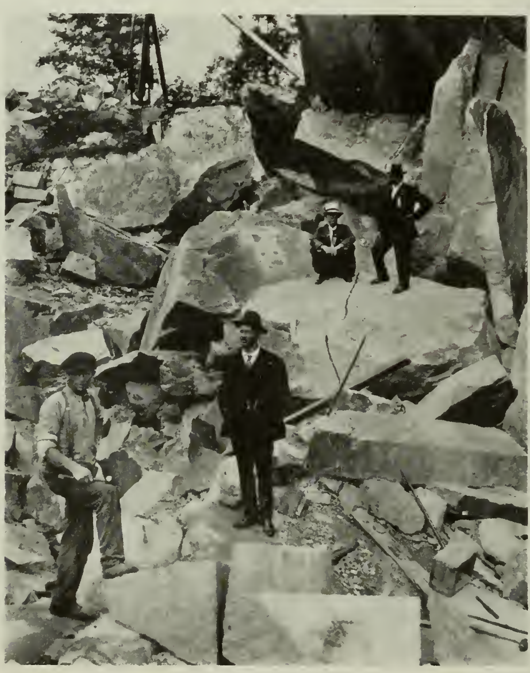


Fig. 7.—Joint blocks of Algoman granite from the quarries of A. C. Brown, Lyndhurst.

These dikes and intrusives vary from fine-grained traps to coarse gabbro-like masses. A microscopic examination of them shows that they are mostly augite diabases, whether fine or coarse-grained. They show the most beautiful ophitic textures, with lath-like blades and crystals of basic plagioclase, cutting into and through large honey-coloured crystals of augite. Their texture is therefore identically like that of the other well-known Keweenawan areas of northern Ontario. Moreover, they carry traces of nickel, a further strong evidence from the standpoint of consanguinity. They are remarkably fresh and undecomposed, and are therefore believed to be the youngest of the pre-Cambrian rocks in this area, Fig. 8.

Nickel and Iron Ore

Dr. Willet G. Miller drew attention to the possible economic value of these basic intrusives in 1897[1] where he notes the occurrence of nickel in the titaniferous magnetites associated with them. An investigation of these titaniferous magnetites showed the presence of nickel in every case, and often cobalt in traces as well. The now famous deposits of nickel, cobalt and silver of the Cobalt region of northern Ontario are of this same age.

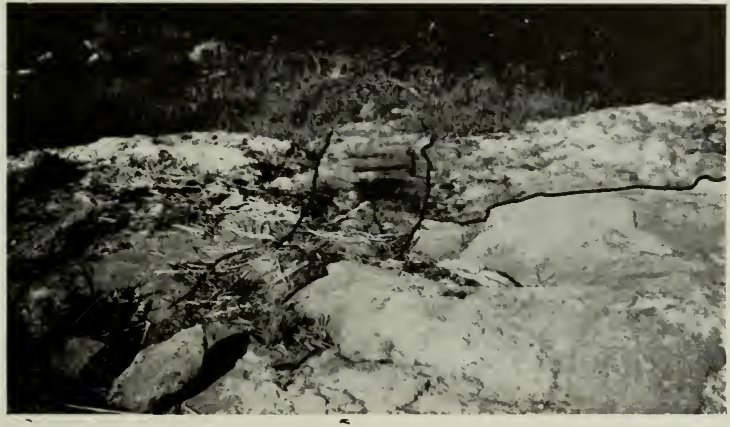


Fig 8.—Grenville crystalline limestone cut by Algoman pegmatite and both of these cut by a vertical dike of Keweenawan trap.

It has also been claimed that the iron produced from titaniferous ores is a tougher and better iron for many purposes than that from non-titanium ores. More recent improvements in electrical smelting strongly suggest a market in the near future, for these hitherto condemned ores.

Regarding segregations of iron ore in the coaser-grained gabbroic masses, only two are found in the area under consideration. They are known as the Chaffey mine, lot 26, con. VI, in the township of South Crosby; and the Matthews mine, lot 1, con. VI, in the township of North Crosby. Both of these deposits were worked as early as 1858, and continued operating in a desultory fashion till 1871. The ore was shipped by water to Cleveland, Ohio, and by rail from there to Pittsburg. Analyses of this ore show metallic iron varying between 50 and 60 per cent., while titanium oxide ran from traces to as much as 16.4 per cent.; no analysis for nickel content was given.

---

[1] Ont. Bur. Mines, Vol. VII, 1897, p. 230.

Cambrian

The intrusions of the Keweenawan period closed the pre-Cambrian in this as in other parts of Ontario. A long interval of weathering and erosion followed, during which the Keweenawan and all earlier rocks were subjected to processes of denudation to such an extent as to produce practically the same topography as we find to-day over the whole of the pre-Cambrian. This must have been a very long period of erosion, for the country was almost base-leveled. This feature has been well preserved by the earliest sediments of the Paleozoic seas; and small outliers of these sediments, which remain to-day, show the underlying pre-Cambrian floor to have exactly the same contour and general character as that of the exposed areas. Glaciation, of course, eroded both the pre-Cambrian and the later rocks, and has served merely to freshen the existing topography of the country, but did not produce it.

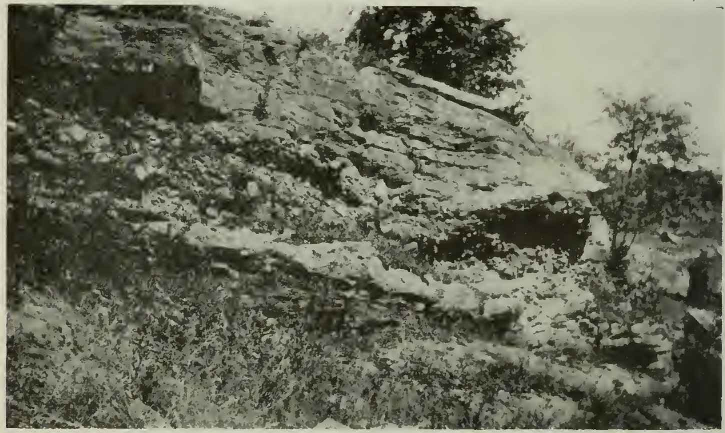


Fig. 9.—Cliff-like front of Potsdam sandstone with conglomerate at base, resting on Grenville gneiss floor.

Overlying this pre-Cambrian floor we find first the Potsdam series. In most places there is a basal conglomerate up to four feet thick, composed of well-rounded, water-worn pebbles and boulders of quartzite, Fig. 9. One striking feature of all these basal conglomerates is the absence of any of the softer rocks. Scarcely any pebbles or boulders of dark gneiss, schists, or crystalline limestone are to be seen, but only the harder quartzite, as stated above.

Iron Ores

In many cases these basal conglomerates are cemented by a brown to deep red iron oxide. This is so abundant in places that some of them have been opened up as prospects for hematite iron, for example, lot 13, Con. IX, and lot 23, Con. X, in the township of Bastard. On these lots a number of pits were opened up, but shipping ore was not found in any appreciable tonnage. Most of the hematite is ochreous, but much of it was solidified to a massive state.

They are merely masses of shattered sandstone and conglomerate richly impregnated by ochreous hematite. In some cases the iron oxides follow down the bed of the sandstone giving the appearance of a true vein, but there is no evidence of filling from below, merely the leaching down of the oxide from the overlying beds of sedimentary rock. In every case the ore is highly siliceous from original sand grains imprisoned with the iron oxide accumulation.

A very interesting deposit of hematite occurs on lot 4, Con. V. in the township of South Crosby. A pocket in the old Grenville crystalline limestone became filled with ochre that had leached down from the overlying Potsdam sandstone. This sandstone had subsequently been eroded so that the pocket of exposed red ochre was left. This was mined and shipped in sacks to a paint factory. The pocket was small, but the few tons of ochre secured were very clean, and of the best quality.

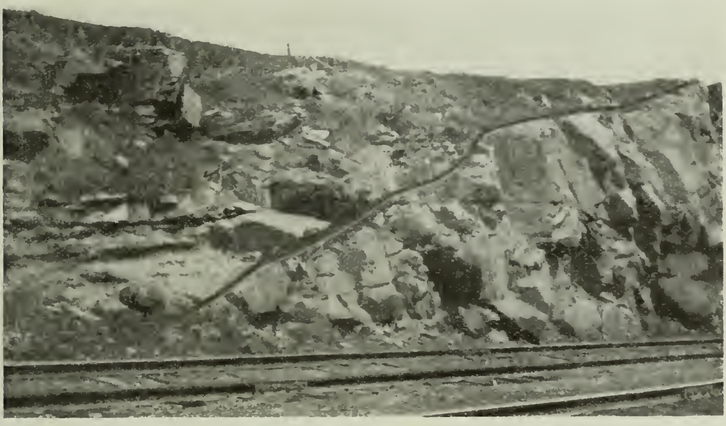


Fig. 10.—Contact of Black River limestone (above) with Algoman granite (below).

Building Stone

Above this basal conglomerate the Potsdam is, as a rule, a rather even-grained, uniform sandstone, with a total thickness of about sixty-five feet. There appear to be two members in the series, one a buff to red sandstone with ferruginous cement, in places upwards of twenty feet in thickness. The other is an equally thick group of sandstones, very pure and very white in colour, and apparently later in age than the red beds.

The buff to red sandstones are not always present beneath the white ones, because they conformed to the surface of the pre-Cambrian floor on which they were deposited. Moreover, they were evidently laid in shallow water, as indicated by the crossed bedding, and the abundance of ripple marks to be found on them. It was pointed out above that the pre-Cambrian area is one of low ridges with hummocky topography, and with broad-bottomed, relatively shallow basins and valleys. The extremes of local relief would seldom be over 150 feet, but even this was sufficient to cause many island-like areas of pre-Cambrian rocks to remain above the shallow Cambrian sea; thus the valleys and basins only would have the earliest sandstone laid down in them. The later white sandstone would in some places cover these, but in many other places would rest directly on the island-like pre-Cambrian areas just mentioned. Even the later Cambrian seas did not entirely submerge all the islands, for in many places the still later Ordovician limestones rest directly on the pre-Cambrian, with splendid basal conglomerates, Fig. 10. In most cases, however, these limestones rest conformably on the sandstones of Cambrian age.

The margins of the limestone as they rest on the sandstones, and of the sandstones as they rest on the pre-Cambrian rocks, are often cliff-like. This is no doubt to be accounted for by the bedding, as well as by the jointing of the sediments, causing them to weather and drop away in blocks, rather than wear down in a tapering contact.

The buff to reddish sandstone of Cambrian age is well adapted for building purposes, and has been quarried and used in many buildings in the county of Leeds. The stone is even-grained, free from fossils or other porous cavities, has good bedding, and a durable cement. The white sandstones are very much harder, and not so well suited to quarrying in building block sizes. They are now being used in large quantities throughout the county of Leeds for road building. Crushed white sandstone yields a good hard road metal, and is giving excellent results on the roads within reach of the deposits.

Paving Blocks

These lighter coloured siliceous sandstones are also suitable for paving blocks, and may be quarried and hammer-trimmed to cobblestone size. The natural bedding planes may be selected to yield layers three and one half inches thick, and from these it is an easy task to trim blocks 3½ x 4 x 8 inches in size. When these blocks are laid on their edges, so that the bedding planes stand vertically, they yield an excellent material for road paving, or for street-railway lining. These blocks are now in use in the city of Kingston. Princess street, the main business street of the city, and the one subjected to the heaviest traffic, has now been paved with these blocks for eight years, and not a stone has required replacement.

When it is remembered that this rock is made up almost entirely of quartz, one of the hardest of minerals, and is bound by a siliceous cement, its great resistance to wear is not surprising. The blocks are much less brittle than paving bricks, and do not readily wear to round edges.

Sandstone for Glass=Making

Believing that this pure white siliceous sandstone had possibilities in the glass and porcelain industries, also possibly for refractory linings of furnaces, the writer collected some of this sandstone, and has made it the subject of a special investigation. An advanced student of geology at Queen's University, J. W. Greig, was given the problem of making a physical and chemical investigation of this material, and the results of his work are summarized as follows:—

In order that a sandstone may be suitable as a source of silica for the manufacture of glass it must fulfil a number of conditions. The most important of these is a required chemical composition. No sand occurring in nature is pure silica, and each of the impurities affects the glass in a different way. The most prevalent impurity is alumina (Al_2O_3). This may be present in the sand in the form of feldspar, clay, or other aluminous silicate, in small pieces which have not been destroyed in the weathering down of the original rock, or as clay between the grains of quartz. The latter is the more likely. Alumina, although an impurity, is not detrimental, however, in the small quantities usually found in a glass sand, but it has the following effects on the glass: (1) It appears to reduce the tendency of a glass to devitrify or crystallize. (2) Three to four per cent. of alumina in a glass renders it less susceptible to the reducing effect of a flame. (3) It reduces the co-efficient of expansion of a glass. (4) It increases the tenacity and the surface tension of the molten glass, and this is very beneficial in moulding. (5) It increases the brilliancy, and decreases the solubility of a glass in water. From the above points and others it will be seen that alumina not above three per cent. is beneficial to a glass rather than injurious.

The most detrimental impurity likely to be found in a sand is iron. It imparts a cream colour to the stone, and washing will frequently remove a great part of it. Ferrous iron, even in small quantities, imparts a bluish to greenish colour to the glass. So common is this impurity that almost any glass, in thick sections, will be seen to have a greenish cast. This effect can often be overcome by what are called discolorizers, the most common of which is manganese dioxide. This material added to a glass imparts a violet shade, which neutralizes to some extent the green due to iron. But this neutralizing is accomplished chiefly by absorption of light rays, so that the transparency of the glass is impaired. Most authorities agree that iron should not exceed 0.05 per cent. in the sand, although the glass sands of Belgium, which are extensively used for sheet and plate glass, contain as much as 0.25 per cent. of iron.

Clay or alumina in glass is said to cause a cloudiness, and consequently any sand with a clay content which cannot be removed by washing should not be used in the manufacture of glass.

Silica is the useful part of the sand, and the percentage should be as high as possible. Whether or not a sand is suitable for glass manufacture can be best seen by a chemical analysis showing the percentages of impurities. Most glass sands contain upwards of 97 per cent. of silica. The sand grains composing the sandstone should be fairly uniform in size. On crushing, the material should break between, and among the grains, rather than across them. The size of the grains is of considerable importance. With large grains the length of time required to flux is longer, and therefore the output of the furnace is lessened. On the other hand, very fine-grained material is said to "burn out" in the batch. Thorough mixing of the ingredients is also very difficult when the grains are very fine, and there is likely to be considerable loss from the finest sand going up the flue with the draught. The most suitable sizes of grain appear to be between 80 and 20 mesh. The grains may be either angular or rounded, and there does not appear to be any consensus of opinion as to which is the more suitable form.

Below are given both chemical and mechanical analyses of two glass sands most used in the United States. There is also a sample of the white Potsdam sandstone collected by the writer. No. 1 is Keystone No. 1, produced by the Keystone works of the Pennsylvania Glass Sand Co., near Mapleton, Penn. This is an angular sand. No. 2 is a well-rounded sand produced by the Wedron White Sand Co. of Ottawa, Ill. No. 3 is the white Potsdam sandstone from lot 19, Con. 1, township of Pittsburg, county of Frontenac, Ontario.

CHEMICAL ANALYSES OF SANDS

No.	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO
1	99.36	0.17	0.06	....	0.12
2	99.45	0.30	0.14	....	0.30
3	99.45	0.11	0.13	....	0.23

A screen analysis of the crushed sandstone, using the W. S. Tyler Standard Screen Scale, was also made and the results obtained from the same three samples follow:

PERCENTAGES RETAINED ON STANDARD SCREENS

	1	2	3
Remaining on 20 mesh	0.07	0.04	0.45
Remaining on 28 mesh, through 20 mesh	1.59	2.16	7.20
" " 35 " " 28 "	13.11	19.01	32.00
" " 48 " " 35 "	61.71	38.04	30.90
" " 65 " " 48 "	20.25	14.19	13.00
" " 100 " " 65 "	2.79	10.15	7.80
" " 150 " " 100 "	0.16	6.65	3.70
" " 200 " " 150 "	0.03	5.68	2.60
" 200 "	0.01	4.70	2.50
	99.72	100.62	100.15

The grains from each screen in analysis No. 3 above, were afterwards examined under a binocular microscope. Those remaining on the 35, 48, 65, and 100-mesh screens were found to have a rounded outline, with facets where the silica cementing them to adjacent grains had broken across. Those below this in size were angular. Over 50 per cent. of what remained on the 200-mesh screen were evidently fracture pieces. Apparently then this sandstone in crushing breaks across the cementing material between the grains, and not across the grains, and therefore yields round sand very like that from Ottawa, Ill. Moreover, the sandstone crushes readily to the sizes indicated above.

It is evident that the white sandstone of Potsdam age is eminently suited to the manufacture of high-grade glass, and for the manufacture of porcelain ware, pottery, earthenware dishes, floor tile, glazes, etc. The supply is unlimited and well situated for rail or water shipment, by the Canadian National railway or Rideau canal. The areas indicated on the map in yellow colour can be quickly run over, and suitable sandstone for any of the purposes required, and the location best adapted for shipment by rail or water, selected. The areas about Delta, Newboro, and Westport seem to the writer to be the most suitable.

Ordovician

The Ordovician sediments overlie the Cambrian sandstones with perfect conformity. The basal beds are shales, sandy limestones, and calcareous conglomerates, whose pebbles are largely quartz, indicating a very thorough disintegration and removal of all softer minerals from the pre-Cambrian rocks from which they were derived. These beds are about 8 feet in thickness, and are followed by a much more compact, finer-grained, dove-blue coloured series of limestones, remarkably free from fossils, and yielding a splendid compact building stone. In crushed form a good road metal for macadam construction is also obtained. This series is about 30 feet in total thickness. No horizon later than the Black River group was observed in the county of Leeds, and if any did exist it has been completely eroded away. The next material to be found above the Black River beds is the unsorted moraine of Pleistocene glaciation.

Glaciation and its Effects

At the close of this long period of time there were three relatively short stages of geological activity which bring us to the present. The first of these was the burial of all eastern Ontario, including the county of Leeds, beneath the Labradorian ice sheets. There is now ample evidence, about the margin of the ice-covered area, that there was more than one advance and retreat of the ice, with inter-glacial periods of considerable duration. In the county of Leeds itself, there is no evidence of these temporary retreats of the ice front.

The second geological event was a submergence of a large portion of eastern Ontario, including the southern part of Leeds, beneath the sea. This occurred towards the close of the Pleistocene epoch, that is, during the final retreat of the ice front.

The third and last episode brings us to the present. After the retreat of the ice, the area slowly rose again from beneath the sea, bringing the Thousand Islands region to its present altitude.

Discussing the first of these three events, we find everywhere the evidence of a great glacial movement from the Labradorian heights, east of Hudson bay, in a southwesterly direction, and extending to the northern part of the United States. Great deposits of till or soil made up of indiscriminate mixtures of clay, sand, silt, gravel, and boulders are found overlying well polished, smoothened, scratched, and gouged rock surfaces. Every trace of decayed or weathered rock has been scraped off, and a fresh surface presented to the renewal of weathering processes. Ordinarily on areas that have not been glaciated, the soil is not marked off sharply from the rocks on which it rests, but shows a gradual passage from surface soil, downward into less and less altered or disintegrated rock, to fresh rocks at the base of the section. The soil is a residual soil left, by the processes of weathering, on the rock from which it was formed. In glaciated areas, on the contrary, the soil bears no relationship to the formations beneath it. It is made up of fine to coarse materials, clay, sand, gravel, and boulders, many of which have no known outcrop for many miles from the place at which they are found. The whole mass is usually quite without any signs of sorting or stratification.

There is no actual means of telling how deep was the layer of residual soil which covered the rocks of this area before the advance of the Labradorian ice sheet, but from the fact that the area was exposed from Silurian times onwards, we might conclude that the residual soil was very deep, and it is extremely doubtful that the pre-Cambrian rocks of this district were exposed, till bared by the Labradorian ice sheets. The many outliers of Paleozoic sediments strongly suggest that they covered all this portion of Ontario previous to the advance of the ice. The writer has described the structure of the pre-Cambrian, and accounted for its topography as being the result of erosion on a series of harder belts of intrusive igneous rocks, with softer belts of schists, gneisses and crystalline limestone. The whole structure was developed northeast and southwest into ridges and valleys, due to differences in the hardness of the rocks involved. The ice movement was, therefore, forced to take this general direction from the Labradorian highlands. When it reached the Paleozoic sedimentary area, its direction of movement was already well established, as is evidenced by the parallel striation and gouges developed on the smooth sedimentary rocks. This is strikingly brought out on the map accompanying this report. The tongues or peninsulas of sediment, as they project southwest from the general area, are most striking, and show that they occupy the pre-Cambrian hollows. Corresponding projecting fingers of the pre-Cambrian rocks in a northeasterly direction, mark the axes of ridges between the depressions filled with Paleozoic sediment.

Lying upon the rock surface, we find a variable thickness of unconsolidated material. Three formations are recognizable, and mark broadly the three episodes spoken of above. The deposits of the first and oldest period are irregular bodies of glacial drift, composed of calcareous clay for the most part, but mixed in many places with sand, gravel or boulders. This represents ground moraine deposited by the glacier with little or no sorting. The greatest advance of the Labradorian glacier was well beyond the southern boundary of the State of New York and northern Pennsylvania. During the slow retreat of the Ontarian lobe of the ice-front, the ponded waters about its front were first drained off through the Mohawk valley of New York State. By further retreat of the Ontarian ice-lobe, the drainage developed farther north in the vicinity of Rome, New York, and later still the ice-lobe retreated sufficiently to allow the overflow of the great glacial lake, lying at the ice-front, to take place around the Adirondack region of New York State, and out by Covey Hill to the Champlain drainage basin.

During all this time the county of Leeds was deeply buried beneath glacial ice, so that none of the re-sorted, laminated clays collected in and about these great lakes were deposited in this county; only the unsorted ground moraine was left here. From Covey Hill, which lies near the boundary between New York State and the Province of Quebec, the land drops away to the St. Lawrence valley, but this was still blocked by ice, and it was only much later, and by further retreat of the ice-front, that the St. Lawrence valley was opened up, and the level of this large glacial lake fell to the then sea level. It was a very different sea level from that of the present time. The finding of marine shells as far up the St. Lawrence as Prescott and Brockville proves that, despite the volume of fresh water entering from the great glacial lakes about the ice front, salt water extended up at least to these places. Up the Ottawa valley, marine shells are similarly found ten miles above the city of Ottawa, and in the county of Leeds the remains of whales were found near Smith Falls. With the opening of the St. Lawrence valley, therefore, and the entry of the sea water to about the eastern end of Lake Ontario, we reach the second stage in glacial deposition in and about the county of Leeds.

Almost everyone in Canada is familiar with the typical glacial drift, and particularly with the boulders or "hard heads" which in so many localities have to be picked up and removed from farming lands. In Leeds there is the usual collection of rounded boulders or rocks from the more northeasterly parts of Ontario. There is an abnormally large percentage of flat flag stones, which represent portions of the Paleozoic sedimentary rocks, torn off and carried along in the basal portions of the ice.

The invasion of the sea just described backing up the upper St. Lawrence river close to Lake Ontario, has been given the name of Gilbert gulf, and it is clear that many of the lower valleys of Leeds county would be occupied by bays of brackish water in which re-sorted glacial drifts would tend to be deposited as well sorted gravel, sand, or bedded clay, depending upon the strength of the current present. This second member of the glacial period is therefore frequently a laminated clay of striking appearance. It consists of a series of thin bands of rich clay, with alternate bands of marly clay or sometimes sandy clay laid in perfect conformity. At the time these banded deposits were laid in the waters of Gilbert gulf, the water level must have stood about 400 feet higher than at present, for geologists of the United States have shown that the beaches of Gilbert gulf, in the vicinity of Waterdown, N. Y., are now about 733 feet above the sea, that is, 487 feet above Lake Ontario. Much of the county of Leeds lies below this level, and remnants of these beds lie in nearly horizontal position almost everywhere. These clays are remarkably free from boulders and pebbles although such are occasionally found, and are believed to be due to droppings from floating ice in Gilbert gulf.

Loam is defined as an intimate mixture of clay and sand, and as many of these laminated clays are interbanded with sandy material, the ploughing of such areas yields the finest of loamy land, and the farmers of Leeds county distinguish very readily their clay land, from their loamy land. During the past abnormally dry season, the loamy land held its moisture so much better than the clay lands that remarkable contrasts in crop could be seen in adjoining fields, or even more strikingly in portions of the same field.

With the final retreat of the glacial ice, and the consequent removal of its great weight, the northeastern portion of Canada began to slowly rise, so that the sea level sank towards its present position, and the St. Lawrence river with its Ottawa tributary developed. Thus the county of Leeds and adjoining areas were soon exposed to the action of weathering and erosion, which has continued to the present time. Along its drainage channels, and in its lower flats alluvial plains were formed. In its lakes re-sorted and bedded sediments are now forming. On its shallow swampy lands, peat beds or marl beds have accumulated, and in many places wind-blown dune sands have collected.

About a mile east of Clark station, on the Canadian Pacific railway, and about seven miles north of Brockville, is a group of sand dunes which overlie the glacial drift. This sand is light pink in colour, and the hills are bare, so that the blown sand is destroying roads and much of the agricultural land in their vicinity. An effort is now being made to clothe them with small pine trees, and areas have been planted in the hope of binding the sand together, and stopping its drifting to adjoining territory. The success of the attempt cannot be told yet, as the planting is too recent.

As mentioned above, local deposits of marl and peat are now forming in the lower marshy areas. The largest of these peat bogs lies about three miles due north of Brockville. It is about one mile wide, and nearly three miles in length, and its longer axis lies as usual about northeast. These deposits make up the third, and most recent group of accumulations of unconsolidated character, and bring us to the present time.

Summary of Economic Minerals

The chief economic features of the area have been dealt with under the various formational divisions in which they occur, but a recapitulation of them here may not be out of place.

The Grenville formation yields crystalline limestone, too coarse for marble, but suitable for lime burning, and for road metal on less travelled roads. The material is too soft, however, to be used where traffic is heavy.

The Grenville gneisses are much used in crushed form for road building, and produce a very good material, especially when rolled in with finer top dressing.

Some graphite and galena are found in the crystalline limestone, but no accumulations of possible economic value were seen in this county. Many small seams of "black lead" or graphite are found amongst the crystalline limestones, but they could not be considered from an economic standpoint.

The Laurentian gneisses are suitable only for road metal in crushed form. Along their contact with crystalline limestones, or with highly calcareous gneisses, is favourable ground for deposits of amber mica suitable for electrical insulators, boiler packing, fire proofing, etc.

Algoman granites and syenites yield the very finest of building blocks, monumental or decorative stone, and paving blocks.

The pegmatitic phases of this formation yield economic deposits of feldspar, suitable for glazing purposes, or in their less pure form for pottery, porcelain, toilet ware, electric insulators, glazed or unglazed ware, floor-tile, etc.

The Keweenawan traps would be the most suitable rocks possible in crushed form for road metal, but are not present in sufficiently large quantity to offer much encouragement in this respect.

The coarse-grained gabbroic members are often associated with magnetite, which carries nickel in most cases, but unfortunately always carries titanium also, which up to this time has caused these ores to be refused by the iron smelter. Recent investigations would indicate that electrical smelting offers some prospect for the use of these ores in the near future.

The Potsdam sandstones are suitable for building stone in rich red to buff colours. The white coloured highly siliceous ones are suitable for road metal, and paving blocks, and the writer suggests their investigation by glass manufacturers, and also by manufacturers of porcelain earthenware, or other products requiring the so-called "flint" of commerce in their process.

The Ordovician is suitable for lime-making, for building stone, and in crushed form for macadam road building.

Unconsolidated glacial drift yields local deposits of gravel or sand for road building, and for concrete mixtures, while local beds of clay, free enough from pebbles, are used in the manufacture of building brick and common field or drain tile.

The following note[1] on iron smelting in the county of Leeds is of historic interest:

> The first iron furnace in this Province was erected about the year 1800 in the northern part of the township of Lansdowne, in the county of Leeds, at the falls of the Gananoque river. The ore used was of inferior quality and had to be drawn a considerable distance, and after two years' trial the enterprise was abandoned. An attempt was made to cast such hollow-ware as pots and kettles for the use of settlers, but that also proved to be a complete failure.
>
> The furnace was erected by a company composed of Ephraim Jones, Daniel Sherwood, Samuel Barlow and Wallace Sutherland, and the location was known as Furnace Falls, now Lyndhurst. In the Geological Survey report for the year 1851-2 Alexander Murray states that the ore[2] used was a "scaly red ore," and was obtained on lot 25 of the 10th concession of Bastard, "but the quantity in the locality worked was not sufficient to give a profitable result."

---

[1] Report of Royal Commission on the Mineral Resources of Ontario, 1890, p. 319.

[2] *See* reference on page 16 under Iron Ores.

INDEX

Vol. XXXI, Part VI.

Page

Acknowledgments 1
Age classification of rocks of area (table) 2, 3
Algoman 10, 11, 24
Alumina 19
Analyses:
  Glass sands used in United States 19. 20
  Gneiss (Grenville) 6
  Gneiss (Laurentian) 8
  Iron ore, Chaffey and Matthews mines 15
  Quartzite (Grenville) 5
Animikie 14
Apatite 9, 10

Baker, M. B. 1*n*
Bastard tp., iron ore 16
Biotite 10
Black River group 20
Breccia 6, 7
Brockville 22, 23
Brown, A. C. 13
Building stone 17, 18

Calcite 9
Calcium phosphate 9
  See Apatite.
Cambrian 16-20
Canadian National Railway 20
Chaffey mine, South Crosby tp. 15
  Iron ore analysis 15
Charleston lake.
  Laurentian intrusives 8
Chemical Products Company, Limited of Trenton, Ont. 9
Chrondrolite 4
Clark station, Canadian Pacific Ry. 23
Cleveland, Ohio 15
Cobalt (mineral) 15
Covey Hill, New York State 22
Crystalline limestone (Grenville) 3, 4, 23
Cushing, Dr. 10, 12

Delta 20
Diopside 4

Feldspar 10, 11, 12
Furnace Falls. *See* Lyndhurst.

Galena 23
Gananoque 8
Gananoque Junction 8
Gilbert gulf 22, 23
Glaciation and its effects 20-23
Glass sands, analyses 19, 20
Gneiss (Grenville) 7, 23
  Analysis 6
Gneiss (Laurentian) 8, 24
Gordon, Charles 13

Page

Granite for building uses 13
Graphite 4, 9, 23
Great War Veterans' Memorial Monument, Lyndhurst 13
  Photo *Frontispiece*
Greig, J. W.
  Quoted on sandstone for glass-making 18, 19
Grenville 3-7, 23

Hematite 4
  South Crosby tp. 17
Hornblende 10

Ingall, E. D. 1*n*
Iron ore,
  Analyses, Chaffey and Matthews mines 15
  Bastard tp. 16, 24
  Smelting at Lyndhurst 24

Jones Falls 8

Keewatin 3
Keeweenawan 14, 15
Keeweenaw Pt., Lake Superior 3
Keystone Works, Pennsylvania Glass Sand Co. 19
Kingston, Ont. 10, 18
Knight, C. W. 3, 10

Lansdowne tp. 24
Laurentian 7-10, 24
Logan, Sir William 9
Loughborough tp., apatite 9
Lyndhurst.
  First iron furnace in Ontario 24
  Memorial monument. . . *Fontispiece,* 13
Lyndhurst Granite Quarries 13

Magnetite 24
Manganese dioxide 19
Mapleton, Penna. 19
Maps (former) of area 1
Matthews mine. North Crosby tp.
  Iron ore analysis 15
McNeill, W. K. 6*n*, 8
Military Surveys Branch. Department of Militia and Defence 1
Miller, W. G. 3, 10, 15
Mohawk valley, New York State 22
Mica 8, 10
Murray, Alexander 24

Newboro 20
Newboro lake.
  Laurentian rock belt 8
Nickel 15
North Burgess tp.
  Apatite mining in (1868) 9
North Crosby tp. 15

PAGE

Ontario Department of Highways .. 1
Ordovician 20, 24
Ottawa, Ont. 22
Ottawa, Ill. 19, 20
Ottawa valley, marine shells 22

Paving blocks 18
Pegmatite dikes 11, 12
Pennsylvania Glass Sand Co., 19
Phlogopite (mica) 4, 9
Phosphate 9
Picton granite 10
Pittsburg tp., Frontenac co., 19
Pittsburg, Penna. 15
Potsdam sandstone 16, 17, 19, 20, 24
Prescott 22
Price, apatite (1868) 9
Pyroxene 9

Quartzite (Grenville) 5

Rideau canal 20
Rideau Mining Company 9
Rocks of the area,
  Age classification 2, 3
Rogers, W. R. 1
Rome, New York State 22
Royal Commission on Mineral Resources of Ontario 1, 24*n*

Sand lake, Laurentian intrusives 8

PAGE

Sandstone. *See also* Potsdam sandstone.
  For building 17, 18, 24
  For glass-making 18, 19, 24
Scapolite 9
Silica 18, 19
Smith Falls, Leeds co. 22
South Crosby tp. 8, 15
  Hematite deposit 17
  Iron ore analyses 15
  Laurentian rock belt 8
Sphene 10
Syenites 10, 24

Thousand Islands region 1, 21
Topography 2

Vennor, H. G. 9
Vesuvianite 4

Waterdown, New York 22
Wedron White Sand Co., of Ottawa, Ill. 19
Westport 20
Whitefish lake 13
Woodburn Granite Quarries, Gananoque 13
W. S. Tyler Standard Screen Scale . 19

Yonge Mills
  Laurentian rock belt 8

Zircons 10

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES   THOS. W. GIBSON, DEPUTY MINISTER

THIRTY-FIRST ANNUAL REPORT
OF THE

ONTARIO DEPARTMENT OF MINES

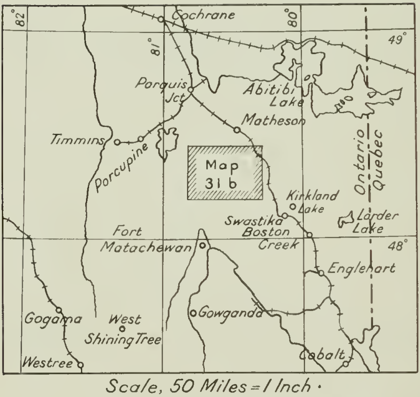
BEING
VOL. XXXI, PART VII, 1922

Geology of the WATABEAG AREA

By Douglas G. H. Wright

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed by CLARKSON W. JAMES, Printer to the King's Most Excellent Majesty
1922



Key map showing location of the Watabeag Area (Map No. 31d.)

CONTENTS

Vol. XXXI, PART VII.

Page
Introduction 1
Previous Work 1
Acknowledgments 2
Means of Access 2
Topography 3
Drainage 4
Waterpowers 5
Timber 5
Agriculture 6
Geological Outline 6
  Keewatin 7
  Algoman 11
  Cobalt Series 15
  Matchewan 15
  Pleistocene 18
Economic Geology 18
  Iron 18
  Copper 19
  Molybdenite 19
  Erythrite (Cobalt Bloom) 19
  Gold 19

Brief Summary of the Townships

  Playfair township 22
  McCann township 23
  Tolstoi and Terry townships 23
  Lee township 24
  McEvay township 24
  Nordica township 25
  Egan township 25
  Sheraton township 26
  Michie township 27
  Timmins township 27

ILLUSTRATIONS

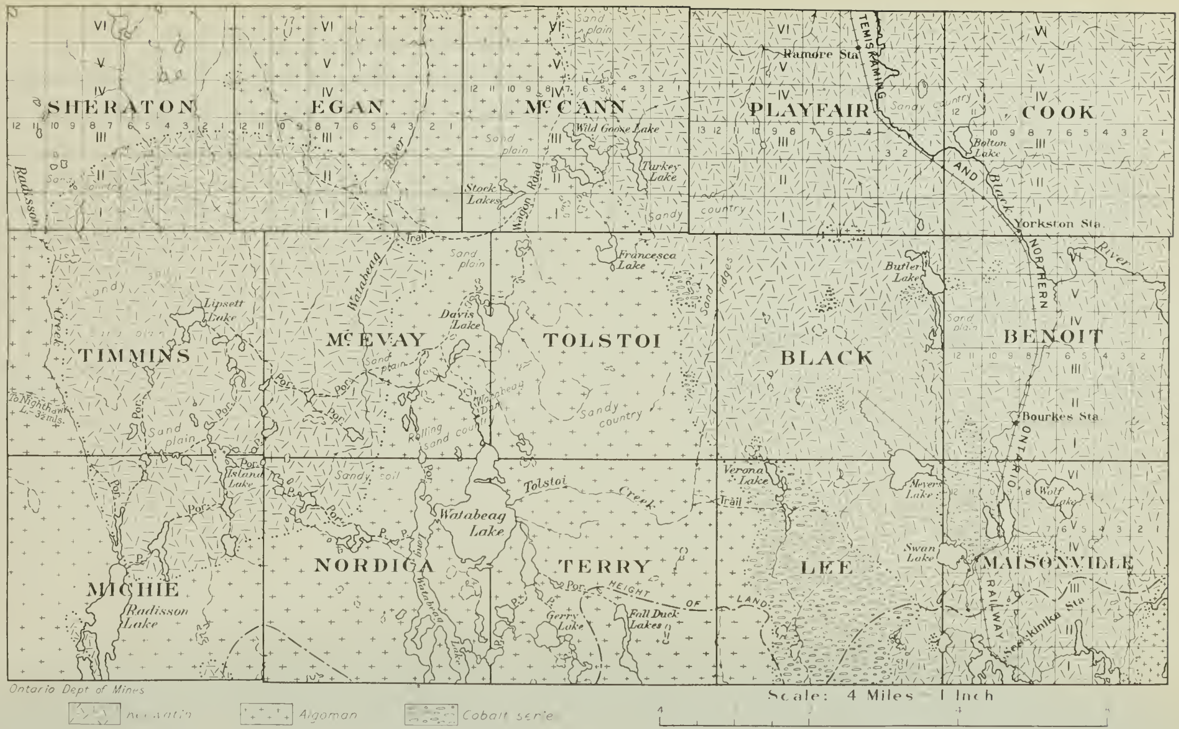
Looking east from west bank of the Black river near Ramore towards Lava Flow Mountain, Cook township. The country was devastated by the Matheson fire in 1916. 3
Waterfall on the Black river, south half lot 3, concession V, Playfair township. 4
Psuedo-conglomerate, lot 1, concession V, Playfair. The hammer rests upon a rounded boulder of pink-weathering feldspar porphyry 8
Psuedo-conglomerate, lot 1, concession V, Playfair. 9
Foliated Keewatin schists containing lenticular-shaped masses of greenstone, situated on the northeast shore of Radisson lake. 9
Pillow lava near Ramore station, north half lot 4, concession V, Playfair. 10
Contact shatter breccia showing rounded xenoliths partly assimilated and surrounded by a hybrid rock. McCann township, lot 7, concession V. 14
Slate-like greywacké member of Cobalt series near $4\frac{1}{2}$-mile post, north boundary of Lee township. The cleavage is perpendicular to the bedding, signifying that the outcrop is near the axial region of a fold. 16
The Black river in Playfair township flows between high clay banks. The view shows the west bank of the river, in concession IV, thirty feet high. Note the stratified clay in the upper part underlain by till. 17
Lemoine lake, Nordica township, typical of the beautiful lakes so abundant throughout the rolling sand country. View looking northwest across the lake from Hill lake portage. 25
A three way contact near the east shore of Saral lake, Timmins township. Fresh diabase, instrusive through Keewatin hornblende schist, and pink-weathering hornblende-feldspar porphyry of Algoman? age. The feldspar porphyry is the light coloured rock in the upper right hand corner of the picture. Contacts have been accentuated with white chalk 29

KEY and INDEX MAPS

Key map, showing location of the Watabeag area (Map No. 31d.) ....(ii)
Index map showing the extent of Algoman granite and syenite, also Keewatin rocks. Only the larger areas of Cobalt series are shown. The two lower tiers of townships are in the distict of Timiskaming, while the top tier forms part of the new district of Cochrane, created October 2, 1922. ....(iv)

GEOLOGICALLY COLOURED MAP

No. 31d—Watabeag Area, Districts of Cochrane and Timiskaming, scale 1 mile to the inch. .... (*In pocket on inside of back cover*).



Index map of Watabeag Area, showing the extent of Algoman granite and syenite, also Keewatin rocks. Only the larger areas of Cobalt series are shown. The two lower tiers of townships are in the district of Timiskaming, while the top tier forms part of the new district of Cochrane, created Oct. 2, 1922.

GEOLOGY OF THE WATABEAG AREA

Districts of Timiskaming and Cochrane

By Douglas G. H. Wright

Introduction

The Watabeag Lake area comprises the townships of Lee, Terry, Nordica, Michie, Timmins, McEvay, Tolstoi, Black,[1] Playfair, McCann, Egan and Sheraton.

The area is contiguous on the west to the Black River area mapped by the writer in 1920 and, as will be seen from the key and index maps, is favourably located with respect to other areas, either of proven worth or of good promise as gold camps. The Porcupine gold area lies to the northwest and that of Kirkland Lake to southeast. To the northeast is the Beatty and Munro gold area and to the southwest lies Matachewan, with deposits of promise. From the fact that Watabeag[2] lake extends into four of the twelve townships of the area and because the basin of the Watabeag river includes more than one half of the area, the name Watabeag seems a suitable one for the report. The height of land between the valley of the St. Lawrence and the Hudson Bay slope passes along the south of the area. The southeast quarter of Lee township and a southern portion of Terry township lie to the south; the remainder of the area is north of the height of land.

The area is roughly four hundred and fifty square miles in extent, and of this almost four hundred square miles were covered during the summer of 1921. Hence it will be realized that the following report must only be treated as a geological reconnaissance of the area, supplemented by more detailed work in localities where geological conditions, or considerable staking, warranted it.

Travel routes were surveyed, micrometer and prismatic compass being used on lake surveys, and pace and compass traverses on portages. The various township boundaries were used as control lines. In the townships which had not been subdivided it was necessary to run pace and compass traverses following as a general rule the diagonals of the township. In subdivided townships lot and concession lines were travelled and claim lines in staked territory. Following the plan instituted by C. W. Knight[3], the dotted courses on the accompanying map, No. 31*b*, show these inland sections so that prospectors may know what parts were examined.

The rock classification used on the accompanying map is largely a field one, based on the megascopic characters of the rocks.

Previous Work

The first geological work in the Watabeag area was done by George F. Kay in 1903. Mr. Kay examined the rocks along the old canoe route to Fort Matachewan, which traverses the chain of lakes through the centre of McCann township, and also rock outcrops on Watabeag lake and along the Watabeag river, from which he also ran several inland sections. The result of Kay's work was published in the 13th Report of the Bureau of Mines, 1904. Since the available supply of this report is limited, some of the more important passages have been quoted herein. Later W. M. Goodwin prospected a part of the area between Gowganda and Porcupine, and a geological sketch map, compiled by him, was published by the Department.[1]

---

[1] Black township has been taken from the Black River Area to complete the block. Ont. Dept. Mines, Vol. XXX, Part 6, 1921.

[2] The writer was informed by Wasil McDougall, an Indian trapper, that Watabeag, translated, means "Northern Lights lake."

[3] Map of Ben Nevis Gold Area, Ont. Dept. Mines, Vol. XXIX, Part 3, 1920.

Acknowledgments

The thanks of the Ontario Department of Mines are due the R. S. Potter Lumber Company, of Matheson, for the many courtesies extended the party while working in the area, and also to the Abitibi Power and Paper Company of Iroquois Falls for the map of Watabeag lake.

The field party consisted of one graduate assistant, J. W. Dougherty, three undergraduate assistants, W. Greenwood and J. C. Macgillivray, of Queen's University, and F. L. Hutchison, of Toronto University, and the writer. Most of the inland sections were done by dividing the party and working in pairs, Mr. Dougherty taking one assistant and the writer the other. Mr. Dougherty must therefore be credited with a large share of the field work.

Means of Access

The Temiskaming and Northern Ontario Railway traverses the townships contiguous on the east, crossing into the Watabeag area along the eastern boundary of Playfair, near the second concession. The eastern townships of the area present individual problems in accessibility, and these will be dealt with later under the heading of the township concerned. The western three-quarters of the area may be reached by the canoe route which follows the old Fort Matachewan trail. This route, however, is not recommended for travel, as it has not been used in recent years. An alternative route is to go by wagon road from Matheson to Davis lake, on the Tolstoi-McEvay boundary, and from there follow the Blackwater-Lockpot lake route to Watabeag lake. From Watabeag lake there are various canoe routes which may be seen on the accompanying map. Practically all portages shown were travelled by our party during the summer of 1921, and were recut and reblazed where necessary. Many of the portages follow sand ridge or sand plain country, and though some of them are quite long the travelling is good. The trip to Watabeag lake may also be made by ascending the Watabeag river from its junction with the Black river as far as the creek outlet of the Davis lake system; but the current throughout the trip and the many log jams encountered make the journey both toilsome and irksome, and hence teaming of canoes and supplies to Davis lake, if not to Watabeag dam, is recommended. The area is also accessible from Nighthawk lake by way of a three-and-a-half mile portage to Radisson (Trout) creek in Timmins township.

The Watabeag Dam road starting from Matheson is suitable for motor car traffic as far as Blackwater lake. Light cars have completed the trip to the dam. During the summer of 1922 the Abitibi Power and Paper Company, Ltd., improved the road from Blackwater lake to the dam, so that motor cars may now make the through trip.

---

[1] Map of part of the area between Gowganda and Porcupine, accompanying Vol. XX, 1911, Part 2, Ont. Bur. Mines Report.

Topography

Much has already been written on the general aspects of various areas comprising the pre-Cambrian Shield region, and a detailed topographical description would be largely a repetition. Topographically, the area exhibits a monotonous undulating landscape, broken occasionally by low, rocky hills, which rise to elevations of only a few hundred feet above the surrounding country. Locally, the country is quite rugged, particularly in the eastern part of McCann township, in the Radisson and Island lake vicinity.

There are extensive sand plain areas, low and rolling, diversified by kettle holes, eskers and an occasional rocky ridge, usually composed of the more resistant rock types, granite and post-Algoman diabase. Plains of another type, not formed by outwash from the glacial ice sheets which overran the country, but caused by the silting in of lakes, are well exemplified in several instances, particularly in Timmins township, stretching north from Dougherty lake, and in Nordica township about the centre, stretching westward from Watabeag lake. Plains of this type are usually ear-marked with ponds which represent the lower declivities of the central portion of the former glacial or post-glacial lake basin.

Looking east from west bank of the Black river near Ramore towards Lava Flow mountain, Cook Township. The country was devastated by the Matheson fire in 1916.

Another striking topographical form is that assumed in localities underlain by sediments of the Cobalt series. Such areas are characterized by valleys and ridges running north and south. The Cobalt series has been gently folded along north and south axes, and the more jointed and broken anticlinal portion has been obliterated by erosion, the synclinal portion forming a ridge. A striking example of this may be seen in the north-south ridge commencing immediately west of Cariad lake in Black township and continuing southward into Lee township, to the west of the chain of lakes which drain into Tomwool creek.

Lakes are numerous, varying in size from mere ponds to those having areas of several square miles, such as Radisson[1] and Watabeag. The water is usually crystal clear, and practically free from organic matter in suspension. Lakes are most common in the sand plain country.

---

[1] There are numerous Trout lakes throughout northern Ontario and for this reason it was deemed advisable to change the name. Radisson was one of Canada's early explorers who discovered the Great North West, ten years before Marquette and Joliet, twenty years before La Salle and a hundred years before De la Vérendrye.

Drainage

The Black river and its tributaries, the White Clay, the Watabeag, the Wildgoose, the Driftwood and their respective creek affluents, drain all of the area excepting the southeast corner of Lee, a small southern portion of Terry township, which lies to the south of the height of land, and the western parts of Michie, Timmins and Sheraton townships which lie west of a secondary divide. Streams in the area west of this secondary divide drain to Hudson Bay through the Nighthawk system, one of the main tributaries of the Moose river. Radisson (Trout), the main creek in this part, is a tributary of the Whitefish river, joining the latter at a point in Thomas township one-and-one-half miles west of the two-mile post on the western boundary of Sheraton. Cautts creek, one of the main creek tributaries of Radisson creek, has its source in Cautts lake. Cautts lake is fed by an underground stream, Mackay creek, which drains Stewart and Mackay lakes and the area east of Radisson lake in Michie township. The point where Mackay creek becomes a subterranean stream was not seen by the writer. That it does follow a course beneath the surface, is commonly known to sojourners in this locality, and this was confirmed by our inland sections. The bottom of Cautts lake appears as numerous springs, and there is a heavy deposition of marl.

Waterfall on the Black river, south half lot 3, concession V, Playfair township.

All the rivers are quite young, possessing V-shaped valleys, and many rapids and falls. Numerous swamps exist, due to the drainage not being well established.

Waterpowers

Small waterpowers might be developed at several points within the area. On the Black river in Playfair township there are two falls, one of about twenty feet in the northwest corner of the north half of lot 2, concession II, and the other with a level difference of approximately 30 feet in lot 3, concession V. On Wildgoose river in the north half of lot 8, concession V. of the same township, there is a falls of 40 or 50 feet already harnessed. The power developed is utilized for operating a small saw mill.

In Lee township, on White Clay creek there is a small, picturesque falls having a drop of twenty feet.

On the Watabeag river there are two falls of note, one in McEvay, slightly north of the centre of the township, the other, called Egan chutes, which is north of the Egan-Currie boundary, just beyond the limits of the area herein described. The first-mentioned is a very pretty falls, at the head of which the river narrows to about fifteen feet, then widens as the foaming waters plunge over the rocky ledges. A hundred yards below this falls the river forms a chute. The total drop, including rapids above and below the falls, is roughly sixty feet. At Egan chutes the water tumbles over a rocky ledge at about forty-five degrees with a level difference of thirty feet. There are points of vantage on the Watabeag river where inexpensive dams might be constructed to permit the storage of almost any desired quantity of water in the Watabeag lake system.

Timber

The area is well forested, but large tracts have been burnt over several times, until in some townships mere remnants only are left of the once green forest. This is particularly true of McCann, Tolstoi and Playfair townships. The timber of economic importance consists of poplar, balsam, spruce, jack (banksian) pine and minor quantities of white pine. The white pine has a fairly profuse distribution around Watabeag lake. Poplar is abundant along the banks of the Watabeag river and in Lee township. The greater portion of the area is sandy; hence jack (banksian) pine is the most abundant.

Forest fires have devastated considerable of the area in recent years. Playfair township was swept by the Matheson fire in 1916. The central portion of McCann is burnt bare. Tolstoi township is largely brulé. Forest fires were active during the long, dry spell in 1921, and swept the eastern part of McCann and the western part of Playfair. During the same period the central and northwestern part of Egan township and the southern portion of Nordica, lying west of Watabeag lake, were devastated by fire.

The western part of the area has not been much travelled in recent years, nor have forest fires devastated it to any extent; as a result wild animals are still fairly plentiful. Moose are numerous, red deer and bear are occasionally seen. The fur-bearing animals are gradually becoming extinct, although beaver are still plentiful. Most of the lakes are well stocked with fish: pike, pickerel, trout and whitefish being the most common species. Watabeag lake fairly teems with lake trout, and in addition to this is a most picturesque spot, readily reached by motor car from Matheson over a good stage road. The lake is an ideal summer camping spot with few rivals in natural grandeur. The sand beaches, with shelving lake bottoms, are splendid for bathing. The trout fishing is unexcelled in northern Ontario. Game in the vicinity of Watabeag lake is still plentiful. The water is transparently clear, as the translation of the Indian name implies. The average depth is thirty-five feet and the maximum sixty-four feet.

The Watabeag basin comprising Main Watabeag, Long Watabeag, Link and Caribou lakes, lies partly in all of the following townships—Nordica, Terry, McEvay, Tolstoi and Sheba.

TABLE OF ACREAGES OF WATABEAG BASIN.

Township	Approx Area
Terry	940 acres
Nordica	838 "
Sheba	77 "
McEvay	59 "
Tolstoi	57 "

The topography of the locality is that of a rolling sand country, with numerous hills and ridges. Sand ridges parallel the lakes, extending in most instances to the water's edge. The stratified sand bluffs, thirty to forty feet high, on the north shore of main Watabeag, near the narrows, and on the east shore, south of the Caribou system inlet, are extremely picturesque. The timber is practically all green, the area having been burnt over about forty years ago. Jack or banksian pine is the dominant species. The jack-pine forest is diversified by small numbers of birch, poplar and white pine, the latter, towering majestically above the surrounding forest. There are several islands, one of rock in the main lake and three small gravel islands and a large sand island in Long Watabeag. From Watabeag lake many side trips may be taken. The portages, for the most part, lead through sandy country which ensures a minimum of hardship in portaging. A good stage road from Matheson to Watabeag dam, on the Watabeag river, renders the locality easily accessible by motor car.

All in all, this centre of natural beauty is warmly recommended to the "back to nature" lover during the summer months.

Agriculture

Excepting the township of Playfair, which is essentially a farming community, only small areas are suitable for agricultural purposes. The soil varies from light to heavy clay and, judging from the crops during the summer of 1921, is quite productive. Other localities suitable for agricultural purposes are in McCann, Egan and Sheraton townships.

Geological Outline

In general the geology of the Watabeag area is similar to that of other component parts of the pre-Cambrian shield, and more particularly to those lying within the boundaries of Timiskaming district. A summary of the geology giving a classification of the rocks according to age relationships, used in this report and on the accompanying map, is given below. The rock formations are in order of age, the oldest being at the bottom of the table.

PLEISTOCENE.	
GLACIAL AND RECENT	Fluviatile and lacustrine deposits of stratified clay and sand, gravel, boulders and till, mostly of glacial origin.
	Great Unconformity.
PRE-CAMBRIAN.	
KEWEENAWAN (Nipissing)	Quartz, diabase and olivine diabase occurring as dikes and sill remnants.
	Intrusive Contact.
ANIMIKEAN (Cobalt Series)	Conglomerate, greywacké, argillite, slate~~-like~~ greywacké, arkose.
	Great Unconformity.
MATACHEWAN	Dikes, frequently characterized by the presence of numerous phenocrysts of labradorite feldspar sometimes 1 and 2 inches in diameter.
	Intrusive Contact.
ALGOMAN (?)	Granite (gneissic in places), syenite, porphyries, aplite and lamprophyre dikes.
	Intrusive Contact.
KEEWATIN	Rhyolite, andesite, basalt, volcanic fragmental, pseudo-conglomerate, old diabases and gabbros, meta-basalt, hornblende, chlorite and sericite schist.

The oldest rocks of the area are of Keewatin age. These rocks are largely basic to intermediate volcanics, and their schistose derivatives. The Keewatin in places has been liberally intruded by acid dikes and a batholith of granite and syenite which are probably of Algoman age. The post-Keewatin rocks have been intruded by dikes of diabase, for the most part quite fresh-looking and frequently characterized by large phenocrysts of labradorite having a greenish colour and a waxy lustre.

Following the intrusion of the diabase was a long period of erosion, after and during which a series of flat-lying sediments, the Cobalt series, was deposited upon the eroded surface of the older basic volcanic and granitic rocks.

No diabase dikes were observed intruding the Cobalt series, but doubtless some of the diabase is of Nipissing age, although considerable of it is thought to be post-Algoman and pre-Cobalt in age. The intimate association of some of these diabase dikes with the granite masses suggests that there may be some consanguinity between the two.

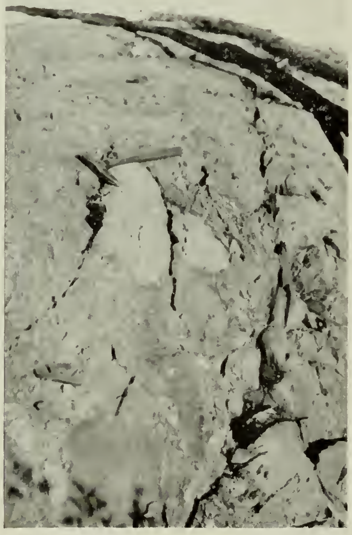
Keewatin

The Keewatin rocks in the area are considered to represent an orderly succession of lava flows, basic for the most part. Rock types identical with the Cook township lava flows[1] were traced westward across Playfair into McCann township but the structure was worked out only in lot 3, con. III, of Playfair township where five distinct flows were recognized, tilted up from the horizontal to an almost vertical position. The strike of the upturned edge of the flows is S. 81° E, magnetic. Amygdaloidal and pillow lavas have a widespread distribution, and in several other localities remnants of distinct flows were recognized. One exposure, easy of access, is in the north half of lot 4, concession V, of Playfair township, a few chains east of Ramore post office. Keewatin rocks in the eastern part of the area, remote from the batholithic intrusion of granite, are fairly massive, and show comparatively small signs of dynamic metamorphism, whereas the Keewatin rocks in proximity to the granitic intrusion have been largely altered to hornblende, chlorite and sericite schists. The most common strike of the schists is between north and west and the dip is usually 60°—70° northeast; some variations to this have been noted on the accompanying map.

---

[1] The Black River Area, Ont. Dept. Mines, Vol. XXX, 1921, Pt. VI.

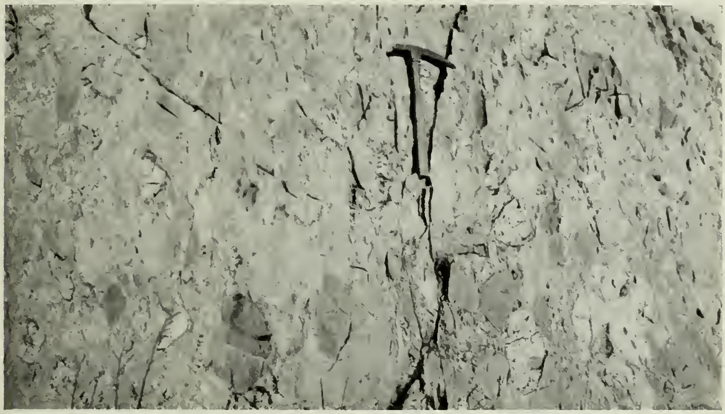
Excellent exposures of pillow lava occur throughout Playfair and McCann. Associated with these are bands of volcanic fragmental material, fine-grained and agglomeratic in character, which doubtless represent tops of flows, the structure being obscured by the overburden.



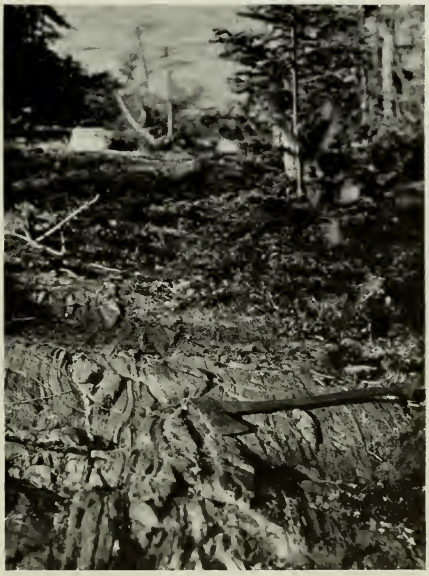
Psuedo-conglomerate, lot 1, concession V, Playfair. The hammer rests upon a rounded boulder of pink-weathering feldspar porphyry.

In the northeast corner of Playfair there are some interesting small exposures of a pseudo-conglomerate. The matrix is quite schistose. the strike being South 60° East magnetic and dip 75° to the south. The pebbles and boulders are of various kinds, elongated parallel to the schistosity and ill-assorted. Boulders up to two feet in diameter are alongside of small stones, from a few inches to a fraction of an inch in diameter. Pebbles of the following were noted—pink granite, feldspar porphyry, basalt, dolerite and amygdaloidal lava. An outstanding feature is the large proportion of granite and pink-weathering feldspar porphyry. Many of these pebbles have been well rounded.

This pseudo-conglomerate seems to be infolded with basic lava flows classed as Keewatin. Under the microscope the matrix appears to be igneous with small



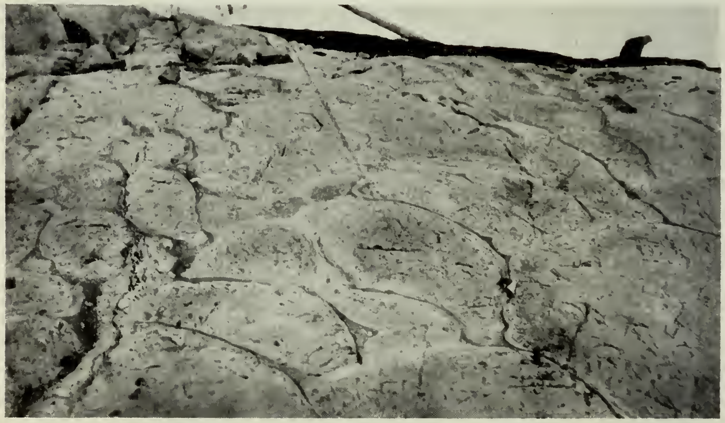
Psuedo-conglomerate, lot 1, concession V, Playfair.



Foliated Keewatin schists containing lenticular-shaped masses of greenstone, situated on the northeast shore of Radisson lake.

crystals of quartz and feldspar in abundant chlorite. The outcrops are small and field relationships obscure. Although these rocks resemble in some respects sediments of Timiskaming age, definite proof of sedimentary origin is lacking. Hence they have been classed tentatively as Keewatin. The possibility, however of these schistose clastics being an infolded remnant of the Timiskaming series must be considered, since these rocks occur in Munro township to the north and east. The outcrop bears a strong resemblance to rocks occurring in lot 5, con. I, Tisdale township, southwest of the Dome mill, and these have been classified by Burrows[1] as Timiskaming.

The Keewatin schist, which surrounds the granite and syenite batholithic intrusion, varies quite locally from black glistening hornblende to chlorite to sericite schist, the first-named being the predominating type. The schist usually has a banded or foliated structure, owing to the parallel alignment of the rod-like crystals of hornblende and infiltration of feldspathic materials in the planes of schistosity. Every occurrence of amphibolite or hornblende schist was in the marginal zone surrounding the intrusive batholith. In many instances a gradation from these schists to typical volcanic types could be traced. In several localities the amygdaloidal structure was preserved, notably in the hill outcrop north of the Sylvia-Sanborn lake portage in Nordica township, and in lot 9, concession II, Egan township. The relationships of these foliated schists indicate that they were all originally volcanic rocks that have been re-crystallized and foliated through the contact action of the intrusive granite batholith. The strike of the schists was found to parallel in a general way the periphery of the intrusive batholith.



Pillow lava near Ramore station, north half lot 4, concession V, Playfair.

On the accompanying map many occurrences of dolerite have been noted. Since this is a general term, it will be defined for the purpose of this report. The word dolerite, as used, covers that class of rocks which range chemically from a diorite to a gabbro, megascopically lacking the ophitic texture characteristic of the diabase, and too fine-grained to definitely show, in hand specimens, whether the predominant ferro-magnesian mineral constituent is pyroxene or hornblende. Rocks of this type have a widespread distribution in the area, and represent to a great extent the central portion of the lava flows.

---

[1] Ont. Bur. Mines, Vol. XXV, 1915, Pt. 3, map No. 24*e*.

Grey lavas and more acidic volcanics, such as rhyolites, are not widely represented in the Keewatin volcanic complex of the area. In several localities acid rocks were noted. The island in the Black river just below the twenty-foot fall, concession IV, Playfair, is composed of acid volcanics. Another occurrence is with the Keewatin schists along the shore of the southwest bay of Radisson lake.

The alteration of the Keewatin rocks, other than the metamorphic effects of the granitic intrusion already mentioned, consists largely in the development of such secondary minerals as chlorite, serpentine, quartz, carbonate, feldspar, epidote, sericite and kaolin. The secondary minerals developed, and the relative proportion of each, depend upon and vary with the original rock type. The ferro-magnesian minerals usually alter to chlorite and epidote. Alteration to serpentine, where observed, was only local and usually along joint planes.

Keewatin rocks west of the eastern boundary of the granite-syenite batholith in general consist of island-like masses, which are considered to be remnants of the original roof of the batholith.

The Keewatin of the Watabeag area has been closely folded. The lava flows have been tilted up from the horizontal into an almost vertical or sometimes a slightly overturned attitude. The axial strike of the folds is always from north 83° east astronomic to due east and west. The axial strike in the Watabeag area is practically identical with that determined for the Keewatin of the Abitibi[1] and the Black river[2] areas to the east.

Algoman

The central portion and western fringe of the area is occupied by a granitic batholith with syenite porphyry facies. Some of the granite is quite similar to rocks farther south referred to as Laurentian.

Certain writers have drawn an arbitrary age line, depending upon whether the dark-coloured constituent of the granite is biotite or hornblende, others have used gneissic textures as a criterion for separating the granites, usually allocating the gneissic granite to the Laurentian. The writer's field experience, however, failed to show these criteria applicable. Practically all of the granites contain both hornblende and biotite, although the former is admittedly the predominant dark-coloured acessory mineral, and gneissic texture is common. The development of gneissic texture is always local and appears to be due to conditions existing during solidification, rather than to regional deformation which would naturally affect the entire mass rather than isolated portions of it.

In the Watabeag area, it was not possible to get any erosive unconformities or igneous contacts between the granitic rocks and older rocks of post-Keewatin age.

Granites of the Laurentian should be, in most cases, more decomposed and disturbed than Algoman granites.

---

[1] Ont. Bur. Mines, Vol. XXVIII, 1919, Pt. II.

[2] Ont. Dept. Mines, Vol. XXX, 1921, Pt. VI.

For the reason that there appears to be no grounds for separating the granites of the area, and, further, as the rocks are comparatively fresh and undisturbed, with one exception to be cited later, they have all been tentatively classed as Algoman.

The granite and syenite is intrusive into the Keewatin and is older than the Cobalt series. The conglomerate of this series is composed largely of boulders and pebbles of reddish hornblende granite and a syenite porphyry identical with the rocks seen *in situ*.

The index map shows the probable extent of the granite batholith. The Keewatin in McCann and Egan townships in proximity to the batholith has been intimately intruded by narrow granitic dikes.

The granite batholith of the area, herein described, is in all probability a part of a huge batholith which extends southward into Robertson, Sheba, Dunmore, Holmes[1], Alma and Cairo[2] townships.

In McCann township, along the Watabeag road, are outcrops of hornblende syenite porphyry. It was observed that the proportion of hornblende increases towards contact with the Keewatin. The syenite porphyry in both Egan and McCann townships is extremely coarse; lath-like phenocrysts, three-quarters of an inch long, are common. In lot 8, concession IV, McCann township, phenocrysts 3 inches long were seen. The porphyry is of a deep pink shade and weathers to a pale pink. Some of the feldspar exhibits zonal weathering. A partial analysis made by W. K. McNeill, Provincial Assayer, of the syenite porphyry from lot 8, McCann township, along the line between concessions IV and V, gave soda 8.66 per cent., potash 3.85 per cent. The feldspar phenocrysts consist of plagioclase and microcline. The plagioclase was proven by means of its index of refraction and extinction angle to be albite. Feldspar forms a high percentage of the rock.

The major occurrences of the coarse albite syenite porphyry are confined to the township of Egan and McCann. In the remainder of the area covered by the granitic batholith the rock type is usually rather syenitic granite with biotite and hornblende as accessories, together with minor quantities of sphene, apatite and zircon. The granite grades without change in texture to hornblende-albite syenite or quartz-albite syenite. In places the former syenite consists of about equal proportions of light coloured minerals and of dark ferromagnesian minerals. The light pink feldspars usually have a pearly cleavage surface.

Kay[3] made rather an exhaustive petrographic study of the syenite exposed on on the island in main Watabeag lake, and his findings are quoted, in part, below:

> Perhaps the most interesting of all the rocks of the area were collected on a small island in Wataybeeg Lake. Two quite distinct types were found, one of which has been called a hornblende-albite syenite, the other a quartz-albite syenite.
>
> The hornblende-albite syenite is a medium-grained phanerite, the individual grains having a diameter of about one millimetre. This rock consists of about equal proportions of light-coloured minerals and of the dark ferromagnesian minerals. The light colored minerals are feldspars, no quartz being present. The feldspars have a pale

---

[1] Cooke, H. C., Exploration of the townships west of Kirkland Lake, Can. Geol. Survey, Summary Report 1919, Pt. E, and Geology of Matachewan District, Can. Geol. Survey, Memoir 115.

[2] Burrows, A. G., The Matachewan Gold Area, Ont. Dept. Mines, Vol. XXVII, 1918, Pt. 1, and the Matachewan Gold Area Ont. Dept. Mines, Vol. XXIX, 1920, Pt. III.

[3] Kay, George F., The Abitibi Region, Ont. Bur. Mines, Vol. XIII, 1904, Pt. I.

pinkish color, pearly cleavage surface, and in patches they exhibit poikilitic effects. The ferromagnesian minerals are hornblende and biotite, the former predominating. In thin section, the prevailing texture is poikilitic; but certain parts present a somewhat graphic texture, due to the interlocking of the crystals; the only constituent, other than the accessory minerals, which approaches automorphism is the hornblende.

The feldspars consist of a plagioclase feldspar and microcline. The plagioclase feldspar was proven, by means of its index of refraction and angle of extinction, to be albite. The albite and the microcline assume several relationships; in some cases, the microcline is poikilitic in the albite; in some cases, the opposite is true, that is, the albite is poikilitic in the microcline; again, the two minerals are coarsely intergrown, in which case an approach to graphic texture is presented, but further examination shows that the two minerals have a parallel arrangement, and hence the texture is really coarsely microperthitic; the albite and the microcline appear to have grown contemporaneously.

The microcline usually shows polysynthetic twinning, that is, lamellar twinning according to the albite and pericline laws.

The albite is also twinned, although many of the crystals are so cut that the striations are not apparent; the prevalent twinning is according to the albite law, but a few Carlsbad twins were also observed. The striations of the albite are very narrow and straight. Of the two feldspars, the albite has suffered the greater amount of decomposition, although both are comparatively fresh.

The hornblende usually occurs in irregular crystals, although automorphic forms in sections cut across the prisms also occur; in such cases the characteristic cleavage is quite perfect. The pleochroism is from a light greenish-brown to green.

The biotite occurs in irregular shaped plates. Its color is brown. The ferromagnesian minerals are poikilitic in the feldspars; both the biotite and the hornblende are somewhat altered.

The subordinate minerals are sphene, which occurs in orange-yellow irregular crystals, and apatite, which is quite abundant in well-formed prisms, some of which are colored by iron oxide. The secondary minerals are a fibrous, light-colored hornblende, which is probably actinolite, a light-colored chlorite and calcite.

An analysis of this rock by Mr. A. G. Burrows, of Belleville, Ont., gave the following result:—

	Per cent.
SiO_2	56.62
Al_2O_3	16.33
Fe_2O_3	trace
FeO	4.21
MgO	7.65
CaO	5.12
Na_2O	4.34
K_2O	2.68
TiO_2	.26
CO_2, H_2O, etc.	2.70

Measurements were made of the minerals present in this rock and the mode determined.[1]

The result was as follows:

	Per cent.
Albite	27.80
Microcline	17.54
Biotite	11.15
Hornblende	42.45
Apatite	.73
Titanite	.29

With these percentages an attempt was made to ascertain what must be the nature of the hornblende to correspond with the composition of this rock as determined by analysis. In this calculation the biotite was assumed to have the composition of the biotite in a quartz monzonite from Walkerville, Butte, Montana.[2]

It was found that the hornblende must be high in silica, high in alumina, high in magnesia, low in iron and low in potassium. A hornblende from Sanlupe was found to have such a composition.[3]

The quartz-albite syenite is found associated with the hornblende albite syenite, the two types seeming to grade into each other. Megascopically, this rock differs considerably from the associated rock, in that it consists almost entirely of light-colored minerals, there being less than five per cent, of ferromagnesian constituents. This rock is also different in that it contains quartz, while mica is absent.

---

[1] Quant. Class. of Igneous Rocks, p. 204.

[2] Table XIV. Quant. Class. of Igneous Rocks.

[3] Dana: System of Mineralogy, page 395.

In thin section, the texture is seen to be similar to that of the hornblende-albite syenite. The feldspars are albite and microcline, which present the same characteristics as were described in the associated rock, but whereas in the hornblende-albite syenite there was less than twice as much albite as microcline, in this rock the albite is about six times as abundant as the microcline.

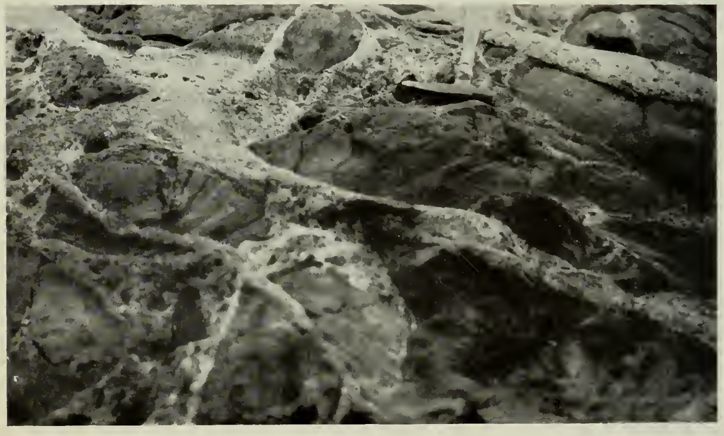
The quartz comprises about 13 per cent. of the rock. It is clear and has xenomorphic outlines. It is usually segregated in small patches.

The ferromagnesian mineral is hornblende, which has a rather deep-green color and constitutes about 5 per cent. of the rock. It shows the usual pleochroism, and in some crystals the characteristic cleavage is present.

The accessory minerals are sphene, apatite, zircon, and a small amount of magnetite.

This rock was also measured and the percentage weights determined. The result was as follows:—

	Per cent.
Albite	69.86
Quartz	13.55
Microcline	11.91
Hornblende	4.26
Apatite	.03
Titanite	.29
Zircon	.06



Contact shatter breccia showing rounded xenoliths partly assimilated and surrounded by a hybrid rock. McCann township, lot. 7, concession V.

In Playfair township, usually in close association with granite or syenite intrusions, a rock occurs which is composed largely of hornblende and biotite, separately or combined with an occasional small crystal of light pink feldspar, standing out in contrast to the darker minerals.

A study of a suite of specimens from the Mobb claim, 1187, northeast quarter of the south half of lot 9, concession IV, revealed evidence of consanguinity between this and the hornblende-albite syenite. In fact, some specimens collected are identical with hornblende and biotite albite-syenite, seen on the island in main Watabeag lake. These rocks were therefore mapped with the Algoman and are considered lamprophyric differentiates from the granite magma. The biotite melaphyre or minette type is of common occurrence among the Playfair lamprophyres.

The only point where the Keewatin-granite batholith contact is well exposed for any distance is in McCann township, where an interesting hybrid facies has been developed. Contact shatter-breccias, showing both angular and rounded xenoliths, are in evidence in the hybrid zone, together with a true hybrid, formed by the digesting of the wall rock by the molten magma prior to solidification. The inclusions or xenoliths are in many instances comparatively unaltered, and their parent rock may be readily determined. The xenoliths range in size from minute fragments to blocks with major axes of 10 to 15 feet, or even larger. The largest are comparatively scarce, the greater number being 2 to 6 feet in diameter, with numberless smaller ones.

Quartz veins in the area covered by the granite-syenite batholith should be carefully prospected for gold, since the deposits of this metal in Cairo and Alma townships, occur with quartz veins in the syenite, presumably a part of the same batholith.

The possible exception of granite of an earlier age than Algoman, previously referred to, is a dike 15 feet wide of schistose granite, with a strike of north 20° west magnetic and an almost vertical dip, which occurs on the east shore of Radisson lake, just north of the southern boundary of Michie township. This dike can be traced to the western shore of the lake, and on account of its appearance it is considered to be possibly of pre-Algoman age.

Cobalt Series

Since all the rocks of the Cobalt series have been fully described by W. G. Miller[1] and others in recent publications of the Department, the writer will refrain from entering on a detailed description of the Cobalt series in the Watabeag area.

Sediments of this series are found mainly in the central portion of Lee township, in the eastern part of Tolstoi township, and in the southeast corner of McCann township. In Lee township, to the west of Verona, Burl and Tomwool lakes, a narrow ridge striking N. 15° W. extends north into Black township. The direction of this ridge outcrop appears to represent the main axis of a fold, for the cleavage is almost perpendicular to the bedding. The dip of the strata rarely exceeds 20°, and is almost invariably to the east.

No younger rocks intrusive through the Cobalt series were found in the Watabeag area.

Matachewan Series

The Keewatin rocks, and the granite and the syenite of Algoman (?) age, are cut by dikes and small masses of fresh diabase. Many of the dikes consist of a coarse quartz diabase frequently containing phenocrysts of labradorite feldspar, sometimes one or two inches in diameter. The phenocrysts have a greenish-yellow, waxy appearance, due principally to sericitization and kaolinization. A coarse porphyry of this type may be seen on the hill outcrop on the northeast shore of Sanborn lake in Nordica township.

---

[1] W. G. Miller, Cobalt and Adjacent Areas, Ont. Bur. Mines, Vol. XIX, Pt. II, 4th Edition.

Besides the porphyritic diabase, there are two other varieties, one an olivine diabase, the other olivine free. The olivine diabase is characterized by spheroidal weathering and in certain instances, notably on the outcrop north from the Toy-Sanborn lake portage, residual boulders may be seen.

At the close of the season, the writer collected a suite of specimens from Diabase hill in the Cobalt area for comparison, and both microscopically and megascopically these rocks appeared identical with the post-Algoman diabase of the Watabeag area. In the field, however, some of the diabase had an older appearance than the Nipissing diabase of the Cobalt area. As no diabase was found cutting the Cobalt series in the Watabeag area, none of it is definitely determinable as Nipissing diabase. An intimate association between the diabase dikes and the granitic masses was noted in the field, which strongly suggests a genetic relationship between at least some of the diabase and the Algoman (?) granites and syenites of the area. Burrows[1] noted an instance where several dikes of fresh diabase lie unconformably below the basal conglomerate of the Cobalt series, and Cooke[2] reports that conglomerate of this series includes boulders of the diabase. Many of the diabase dikes of the Watabeag area are

Slate-like greywacké member of Cobalt series near 4½-mile post, north boundary of Lee township. The cleavage is perpendicular to the bedding, signifying that the outcrop is near the axial region of a fold.

---

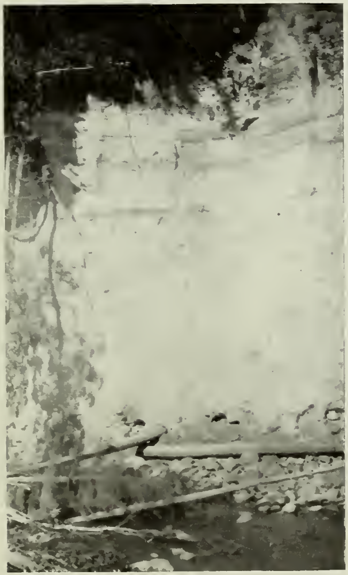
[1] The Matachewan Gold Area, Ont. Bur. Mines Report, Vol. 27, 1918, Pt. I, page 229. Gowganda and other Silver Areas, Ont. Dept. Mines Report, Vol. XXX., Pt. III., 1921, p. 8.

[2] Geology of Matachewan District, Geol. Sur. of Can., Memoir 115, p. 33.

considered to be the correlatives of the diabase of the Matachewan area to the south, the age of which, as has been pointed out, was definitely affixed as post-Algoman and pre-Cobalt. Separation of these diabases, post-Algoman and pre-Cobalt, and Nipissing, on petrographic grounds would indeed be difficult if not impossible. Therefore the strong possibility of some of the diabase being the correlative of the Nipissing diabase must be considered.

In the vicinity of Island lake, Michie township, some small isolated occurrences may possibly be sill remnants.

The contacts in the majority of cases were not exposed, but, to cite an instance, on the east shore of Island lake a sill remnant of a fresh diabase appears to rest unconformably upon the eroded surface of the Keewatin schists.



The Black river in Playfair township flows between high clay banks. The view shows the west bank of the river, in concession IV, thirty feet high. Note the stratified clay in the upper part underlain by till.

The dikes have a vertical attitude, or nearly so, and usually a northerly strike. The exomorphic effects of the diabase are unimportant, and only extend into the intruded rock a few inches from the contact.

Narrow alpite dikes and feldspar-porphyry dikes frequently cut the diabase. These are regarded as an acid facies of the latter. Dikes of this nature are to be seen on the hill outcrop west of the Watabeag river, on the north boundary of Egan township, and on the northeast shore of Wildgoose lake in McCann township.

Pleistocene

Superficial deposits of unconsolidated material cover a great part of the area. These drift deposits consist largely of sand, gravel, stratified clay, or sand and clay. The townships of McCann, McEvay, Tolstoi, Terry and Nordica comprise, in the main, one vast undulating sand area. Here and there are sand ridges and hills which stand out prominently above the surrounding country. Although the glacial trend in the area, as revealed by striæ, is about 10° east of south, the majority of the moraines and eskers have either a northwest and southeast or an east to west trend. The area presents many interesting glacial features which do not fall within the scope of this report, requiring as they do a detailed topographical study for proper and intelligent interpretation.

Economic Geology

Speaking generally, from an economic viewpoint the geological work proved disappointing, for much of the area is both overlain by swamps and sandplain and underlain by hornblende granite. The Keewatin rocks near the margin of the granitic batholith are favourable for prospecting.

Geologically, the area is more favourable as a possible gold producer than for any other mineral. Gold discoveries have already been made at several widely distributed points i nthe area, viz., in Playfair, in Terry, in Egan and in Timmins townships. These prospects will receive particular mention later.

Small deposits of fluorite have been found in Cairo and Alma townships in the eastern part of the Matachewan gold area.[1] They occur in quartz veins in syenite, Since the syenite of the Watabeag area is thought to belong to the same batholith, and owing to the widespread occurrence of fluorite in the area contiguous to the south, prospecting might be rewarded by the finding of economic deposits of this mineral. Small quantities of fluorite were seen in a quartz vein on the west shore of Radisson lake near the bay.

Barite veins of commercial importance have been found cutting the red syenite in one instance, and the Cobalt series slate and quartzite in another, in the Matachewan area. There is a possibility of making similar discoveries in the Watabeag area.

Iron

On the southern boundary of lot 12, concession II, Egan township, there is a small deposit of magnetite, with a minor quantity of chalcopyrite, occurring as a magmatic differentiate from the post-Algoman diabase. Some of the chalcopyrite exposed to weathering conditions is altered to the blue basic cupric carbonate, azurite. The outcrop at the point of concentration of the magnetite is quite small, but the diabase appears to underlie the whole lot and appreciable local attraction was noted in this locality. It was, therefore, deemed advisable to mention this occurrence, since differentiation from similar magma has in other areas yielded deposits of economic importance. Complementary dikes, further evidence of magmatic differentiation, were noted in the same locality. Several specimens taken from the outcrop were tested for chromium with negative results. Titanium is present.

---

[1] Burrows, A. G., Matachewan Gold Area, Ont. Dept. Mines, Vol. XXVII, 1918, Pt. I.

Copper

Copper-bearing minerals, principally chalcopyrite, were observed in numerous localities throughout the area, but in no place was a deposit of sufficient extent seen to be of commercial value. In the area chalcopyrite usually occurs in a quartz gangue as small aggregates or minute disseminations throughout the fresh diabase or aplite dikes, genetically connected with the diabase.

Molybdenite

Molybdenite was seen in a pegmatite dike in the granite on the Biederman claim, D.G. 67, on the south boundary of Terry township, and also on claim 17010 on the north boundary of Timmins township. The Timmins township occurrence is at the margin of a quartz vein 16 inches wide, striking S. 80° W., and dipping 60° north. In both instances cited the quantity of the mineral is small.

Erythrite (Cobalt Bloom)

Cobalt bloom was identified by the writer from a narrow calcite vein in proximity to the diabase dike which strikes in a northerly direction from the Radisson-Currie lake portage. The quantity was too small to be of economic importance, but at the same time it points to calcite veins in the vicinity of the diabase dikes and sill remnants being worthy of attention as possible sources of silver. This mineral, cobalt bloom, has to date in the Province of Ontario been associated with Keweenawan (Nipissing) basic intrusions, with which are also associated the silver, nickel, and arsenic of Cobalt, Ontario, and elsewhere in the Province.

Gold

Gold discoveries have been made at several points in the area, notably in Playfair, Timmins and Terry townships. The discovery of gold in Playfair township was practically the first in north-eastern Ontario. The Ontario Land Survey party working in Playfair township first noticed the occurrence in 1905, and the news soon spread. Claims were staked by Messrs. Mercer, Mobb, Legris, Tabicoe, Gould and others, early in the spring of 1906.

The discovery of gold in 1908 along the south boundary of Terry township in the Fall Duck lake vicinity led to a mild rush to that part of the area. This was known as the "Caribou rush" of 1909. Other gold discoveries have been made, but no work has been done in late years on any of the discoveries.

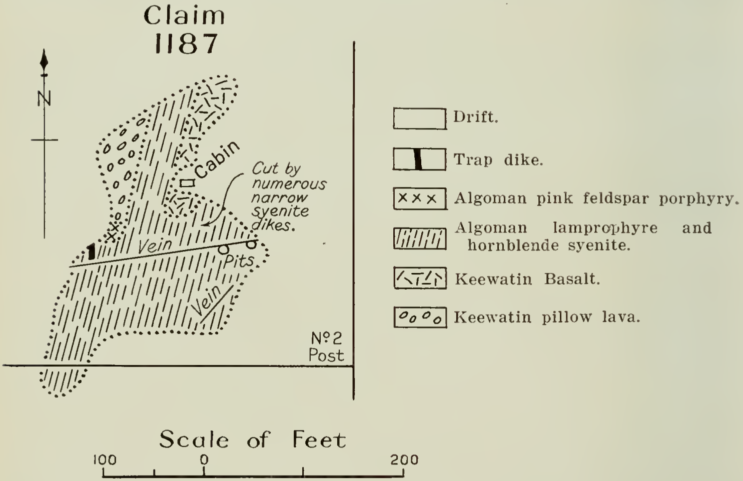
While the economic importance of the gold deposits so far discovered in the area is still quite problematical, they at least afford another striking example of gold being derived from acid intrusives of Algoman age.[1] This relationship is particularly well exemplified by the occurrence of gold in a pegmatitic vein in the granite on Biederman claim, D.G. 67, in Terry township. All gold discoveries to date, in the area, are in close proximity to the granite, syenite or feldspar porphyry, all of which are considered to have a genetic connection, being different facies of the same parent magma. In the proximity of these acid intrusions is a favourable locality to prospect for gold.

A few of the claims upon which gold has been found are now described:

---

[1] W. G. Miller and C. W. Knight in a paper entitled "Metallogenetic Epochs of the pre-Cambrian of Ontario," Transactions of the Royal Society of Canada, Series III, Volume IX, 1915, allocated most of the gold deposits of Ontario to the Algoman Metallogenetic epoch.

Mobb claim, 1187, is the northeast quarter of the south half of lot 9, concession IV, Playfair township. The rock outcrops are confined largely to the southeast portion of the claim. Two test pits have been sunk on the main discovery, which consists of three parallel veins that strike east and west magnetic, and dip almost vertically. The north and south veins consist of a quartz and calcite gangue slightly mineralized with iron pyrites, chalcopyrite and minor amounts of molybdenite. The centre vein is practically barren, and has tight walls, whereas the walls of the south vein are well defined. The wall rock on the north is a coarse-grained phanerite, a hornblende-albite syenite. This rock consists of about equal proportions of light-coloured minerals and of dark ferromagnesian minerals. The light-coloured minerals are a plagioclase feldspar, albite and microcline with a pinkish colour and pearly cleavage. The ferro-magnesian minerals are hornblende and biotite, the former predominating. The rock is intimately cut by narrow pink syenite dikes, practically free from any ferromagnesian minerals. Porphyry dikelets from one to a few inches wide cut the intervening rock between the north and south vein. The most easterly test pit has been sunk on the junction of this parallel vein system, and a barren, milky-white quartz vein striking northeast and southwest and dipping 45° northwest. The white quartz vein is paralleled by several narrow felsite dikelets, and is capped on the surface with magnetite. A chip channel sample on the parallel vein system taken across four feet on the most westerly test pit gave $60 in gold and 9 ounces in silver per ton. Values are erratic, however, as a second sample did not give such encouraging results. The owner, Frederick Mobb, having made an initial discovery of gold, was given a free grant under the Mining Act of Ontario. The patent to the property was not received until 1920, and nothing was done upon it from 1909, when the assessment work was finished, until the summer of 1920, when Mr. Mobb revisited the claim with a view to further testing it.


Claim
1187
N
Cabin
Cut by numerous narrow syenite dikes.
Vein
Pits.
Vein
N°2 Post
Drift.
Trap dike.
Algoman pink feldspar porphyry.
Algoman lamprophyre and hornblende syenite.
Keewatin Basalt.
Keewatin pillow lava.
Scale of Feet
100
0
200

Surface geology on Claim 1187. Some gold values are found in main east-west vein.

Biederman claims, D.G. 67 *and* 15740, are situated along the south boundary of Terry township near the two-mile post, and extend south into Dunmore township. The discovery was made in 1908, and a shaft was then put down to a depth of 20 feet on a quartz pegmatite vein, about 25 feet wide, cutting a pink granite, having biotite and hornblende as accessory minerals, the former being the more plentiful. The vein strikes S. 25° E. magnetic, and dips about 85° E. The footwall is obscure; the immediate hangingwall is a biotite melaphyre. The biotite melaphyre passes gradually into a pink biotite granite. The schistosity conforms with the strike of the vein. The central portion of the vein is barren, white vitreous quartz, with little gossan. Near the margin there is a patchy mineralization of iron pyrites, chalcopyrite and molybdenite. There is considerable feldspar with the quartz. A picked, heavily mineralized sample containing all of the minerals mentioned did not yield an encouraging assay in gold or silver.

A road was cut along the south boundary of Lee and Terry from Sesekinika lake in Maisonville township to the property. A diamond-drill outfit was taken in over this road in 1914, and several holes drilled by a prospecting company from New York. The writer is indebted to William Biederman, the owner, for the following particulars relative to the diamond drilling.

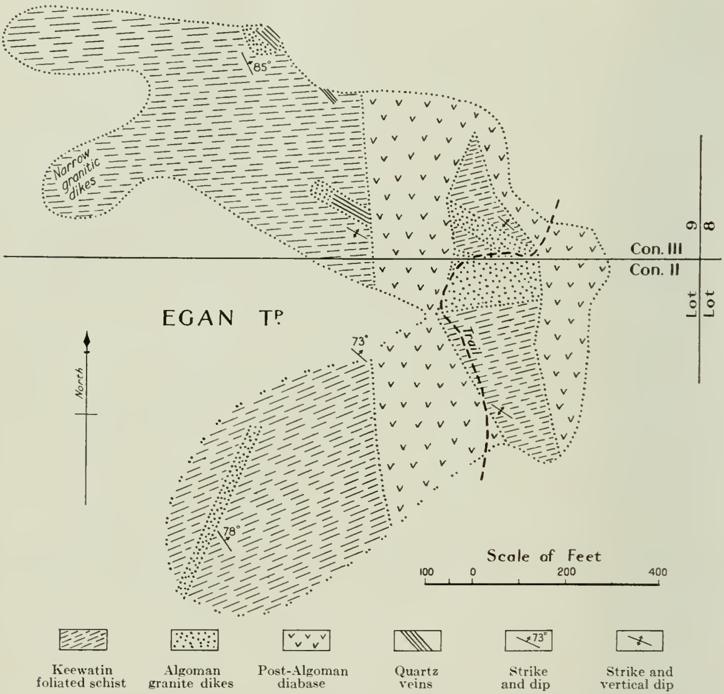
No. 1 hole	depth 125 feet	dip 75°
No. 2 hole	“ 320 feet	“ 85°
No. 3 hole	“ 269 feet	“ 60°
No. 4 hole	“ 300 feet, 10 in.	“ 60°

All holes were drilled from the footwall side of the vein. Values of 90 cents to $14 in gold and two to three ounces of silver per ton were obtained. All the assays were made of core from No. 3 hole, which was drilled 120 feet in quartz at an angle of 60°.

These values, while interesting, give no conception of the economic importance of the deposit.

Lightning River Gold Mines, Ltd.—This company owns four claims in Egan township, two patented, described as parcels 2443 and 2444, and two numbering 8499 and 8500, respectively comprising the south half of lot 9, concession III, Egan township. As will be seen from the plan on page 22, the discovery is near the Keewatin schist-granite contact. The main outcrop is near the centre of the four claims, and consists of Keewatin schists, hornblende and chlorite schist being the two prevailing types. The strike of the schist varies from east and west astronomic to N. 35° W. The dip is to the north and northeast at steep angles of 65 to 75 degrees. The Keewatin schists have been intimately intruded by narrow granitic, some porphyritic, dikes. The dikes have no regular strike, but in a general way it is parallel to the schistocity of the Keewatin. In the main outcrop there is a sheeted zone slightly over 100 feet wide and exposed along the strike for several hundred feet. The schists in this zone strike N. 37° W., dip 65° N.E., and are cut by a narrow quartz vein striking S. 53° E. The intervening rock and the quartz veins are slightly mineralized with cubical iron pyrites. The schists are locally altered to a ferruginous carbonate. There is a series of joint fissures at right angles to the main fracture. Grab samples, as nearly representative as possible, taken from sixteen different points across this sheeted zone, gave low gold values.

No work of any account has been done on the claims since 1916. During the summer of 1921 a cabin was built with a view to further prospecting the property.



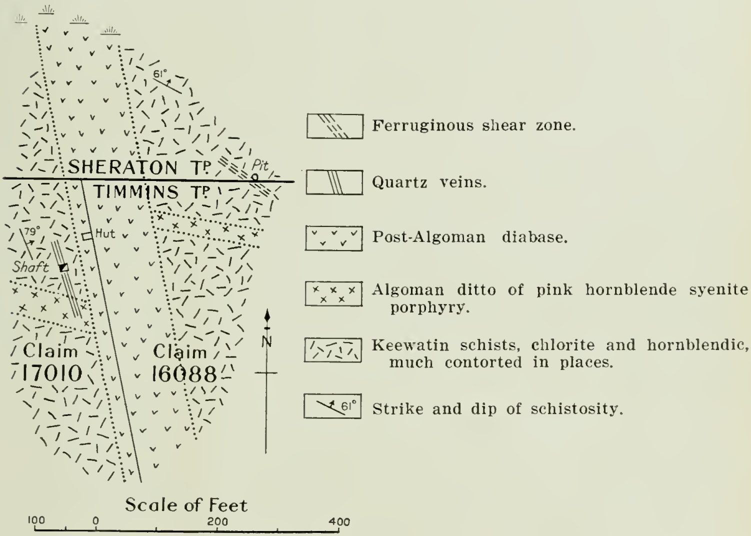
Claims of Lightning River Gold Mines, showing geological relationship of rocks typical of the Watabeag area. Small gold values were obtained from quartz veins cutting the granite.

Claims 17010 *and* 16088 are located along the north boundary of Timmins township at the southwest corner of Egan township. Considerable surface work has been done on these claims and a shaft sunk, judging from the dump, to a depth of 25 or 30 feet, near the hornblende-syenite porphyry-chlorite schist contact, on several parallel veins striking N. 6° E. magnetic. The gangue is largely quartz with minor quantities of calcite, ankerite and a carbonate, probably brunnerite (carbonate of iron and magnesium) judging from its tan-coloured weathering. The veins are mineralized with cubical iron pyrites.

The quartz veins cut both the Keewatin schists and the syenite porphyry, but the mineralization is largely confined to that part of the vein lying outside the porphyry. South of the shaft there is a small schistose felsite dike intrusive through the Keewatin schists.

From a representative grab sample of the vein material, an assay of $10.40 in gold per ton was obtained. Gold was seen in several specimens found on the dump.

On claim 17010, near the southeast corner, a test pit 13 feet deep has been sunk on a white vitreous quartz vein striking S. 80° W. magnetic, and dipping 60° N. The mineralization is scant. Along the footwall side of the vein there is a belt varying from a few to 18 inches in width, which contains considerable molybdenite and ankerite. The hangingwall has been altered to a ferruginous carbonate. Judging from material on the dump, the vein is associated with a deep pink to red coloured felsite dike. This dike was not seen on the outcrop. The footwall rock, carrying considerable molybdenite, showed only a trace of gold.


61°
SHERATON TP.
Pit
TIMMINS TP.
79°
Hut
Shaft
Claim 17010
Claim 16088
N
Ferruginous shear zone.
Quartz veins.
Post-Algoman diabase.
Algoman ditto of pink hornblende syenite porphyry.
Keewatin schists, chlorite and hornblendic, much contorted in places.
61°
Strike and dip of schistosity.
Scale of Feet
100
0
200
400

Geology of parts of Claims 17010 and 16099.

A speck of gold was seen in a narrow dike composed of dark aphanitic rock cutting a granitic boulder. The boulder was along the south boundary of Lee township, just west of the five-and-a-half mile-post. From the angular nature of the boulder and its many associates, and from the fact that the granite was identical with that seen *in situ* a few chains east, it doubtless was not transported far from the northward.

Panning of the glacial gravel and sand in the vicinity of Wolverton lake, in Timmins township, is reported to have yielded a few colours to the panful. Since the sand and gravel is purely of glacial origin, there is little chance of a natural concentration having been effected to a sufficient extent to form deposits of economic importance.

Brief Summary of the Townships

Playfair Township

The northeast quarter of Playfair township in traversed by the Temiskaming and Northern Ontario railway. Roads have been cut and graded in all but the southwest quarter of the township. Hence all parts are easily accessible. The greater part of the township is overlain with a heavy mantle of clay soil, well adapted for agricultural purposes. The arable lots are practically all taken up, and already there are many well improved farms. As a result of the Matheson fire in 1916, much of the land was easily cleared, and Playfair township now presents a well-settled appearance, and an uninterrupted view of the undulating clay land may be had across several concessions.

Ramore village, along the T. and N. O. railway, in concession V, is a thriving community. The village had, in the summer of 1921, a post office, two general stores, a bank, two restaurants, a boarding house, a blacksmith shop, three sawmills, a public school, a separate school and a Roman Catholic church. In growth this village rivals some of the western prairie towns, for it has been built up since 1912, when the first farm settlers came in.

The present postmaster, T. E. Cocklin, has been a resident of Ramore since 1908, before the township was thrown open for location. In 1908 Ramore was called Wildgoose siding. In February, 1909, a post office was opened at Ramore station as Clay Belt post office, a name afterwards changed to Ramore. The greatest influx of settlers came between 1914 and 1918, and it was not till following the Matheson fire in 1916 that the community and town spread west of the railway.

The entire township is underlain with Keewatin, possessing all the characteristics of extrusive lava flows. Locally, this basement of volcanic rocks has been liberally intruded by acid dikes, granite and syenite, frequently porphyritic and lamprophyre dikes. A promising locality, worthy of further prospecting for ore deposits, is in lots 7, 8 and 9, concessions II, III and IV. The most rugged country is situated along the southern and western boundary line. A splendid view of the entire township may be obtained from the summit of Kempis mountain, on the eastern boundary line.

Small values in gold were obtained from quartz veins cutting the Keewatin rocks in the north half of lot 13, concession V.

McCann Township

Topographically, the township of McCann may be roughly divided into three parts. The eastern third is rugged and underlain with Keewatin rocks; the central third is a rolling sand country which strongly suggests recessional glacial material; and the western third may be separated into the south half, which is flat land more or less swampy, and the north half, which is undulating land with a good mantle of clay loam, suitable for agricultural purposes.

The central rolling sand plain area has been repeatedly burned over until it is quite bare. There are areas of good poplar in the northwest quarter and considerable spruce in the southeast quarter. Some small remnants of the original jack pine forest still remain in the southern part.

The northeast quarter of the township is particularly rugged, and forest fires have bared the rock. The Keewatin rocks in this section have been cut by numerous narrow dikes of Algoman age. There are many high, rocky hills in the northeast and also along the Keewatin-granitic batholith contact, which runs roughly north and south across the centre of the township. In the southeast quarter there are a few outcrops of the Cobalt series.

Small lakes are numerous in the sand-covered part of the township.

The Matheson-Watabeag Dam road crosses about the centre of the township from north to south.

The most promising localities for prospecting are accessible from De Courcey, Wildgoose and Turkey lakes. Some recent staking has been done in the vicinity of Andrew lake, on lot 7, concession VI.

Tolstoi and Terry Townships

The townships of Tolstoi and Terry may be described together, since geologically and topographically they are somewhat similar. In the main they are characterized by rolling sand plains with occasional areas of considerable extent of flat land, more or less swampy. The sand ridges have two general strikes, east to west and northwest to southeast. The country north of Tolstoi creek in Terry is mostly swampy.

The central portion of Tolstoi has been swept by forest fires, which have destroyed considerable of the jack pine forest, but quantities of splendid jack pine still remain. Only minor tracts of agricultural land exist, and these are confined to the eastern part. They are not of sufficient extent to warrant subdividing the township.

Tolstoi township is not easily accessible, and has been but little travelled. From the prospector's viewpoint there is little of interest, since the rocks are almost entirely covered. Only here and there do small outcrops of the underlying granite and syenite occur. A strip along the east of the township, one mile wide from east to west, is underlain by Keewatin rocks. The bedrock in the remainder of the township is inferred to be granite and syenite, cut by numerous dikes of fresh diabase. Some small outcrops of the Cobalt series conglomerate and greywacké are scattered throughout the eastern third of the township.

A canoe route, which can be readily followed upon the accompanying map, leading from Caribou lake, makes all parts of Terry township comparatively accessible. Tolstoi creek, if cleaned out, would be suitable for canoe travel, but in its present condition is not navigable. A rough road has been cut west from Sesekinika lake, Maisonville township, to mining claim D.G. 67, situated at the two-mile post on the southern boundary of Terry township.

The rock outcrops seen, which are by no means numerous, except in the eastern third of the township, consist wholly of granite and syenite cut by fresh diabase dikes. The occurrence of gold in a pegmatitic quartz dike cutting the granite has already been mentioned.

Lee Township

White Clay creek, which empties into Meyers lake, is navigable by canoe during high water, but in shallow water the swamp willows, which in many places overhang its banks, make travel tedious. This creek and numerous lakes render the township reasonably accessible. The forest is green, with the exception of a small area surrounding Sarsfield Lake and extending westward along the southern boundary. The entire township is well timbered, principally with poplar, spruce and jack pine. Lee township is part of a timber berth held by T. S. Woollings & Co., of Englehart. The only pulpwood cut so far is in the vicinity of Meyers lake, where the company has erected huts.

The surface of the area is mainly rolling in character. The southwest part is low and swampy and spruce-covered, the east and north consists of more elevated clay land timbered with birch and poplar, and the southeast is a rolling sand country dotted with numerous small lakes of crystal clear water. A commanding view of the entire township may be had from the outcrop situated in the southeast corner of Terry township, a few chains west and north of the southeast corner. A feature of the topography is the north to south ridges of the Cobalt series.

The western fringe of the township is underlain by granite, the central belt by sediments of the Cobalt series, and the eastern portion by Keewatin rocks.

Some claims have been staked near the Lee-Maisonville boundary.

McEvay Township

McEvay township is well provided with means of access both by land and water. Wagon roads lead from the main Watabeag Dam road to the various camps along the Watabeag river. Most of these are shown on the accompanying map. The Watabeag river is quite suitable for canoe travel except during seasons when the timber drive is on.

The Watabeag river flows from south to north roughly across the centre of the township. The banks are high, in places 60 feet, composed of sand and gravel above the falls; below the falls, the soil is clay and clay loam and the timber along the banks changes from jack pine and poplar to spruce of merchantable grade. In the country lying to the east of the Watabeag river considerable valuable timber, mostly jack pine, has already been cut, but some patches of this pine of fine quality still remain, particularly along the Watabeag Dam road. West of the river practically no timber has been cut except along the river bank.

The entire township is covered with a heavy mantle of sand and gravel. Rock outcrops were seen only along the Watabeag river, and the northern and western boundaries of the township. Some rock, not definitely *in situ,* seen along the river between Lockpot lake and Watabeag dam has not been shown on the accompanying map.

Lakes are especially numerous in the southern half of the township. The northwest quarter consists of alternating sand and spruce swamp.

Many sand hills and ridges lend variety to the otherwise monotonous landscape. The usual strike of sand ridges is either east-west or northwest and southeast.

Lemoine lake, Nordica township, typical of the beautiful lakes so abundant throughout the rolling sand country. View looking northwest across the lake from Hill lake portage.

Nordica Township

Nordica is a township of varied topography, possessing as it does, rolling sand plain country, spruce muskeg and many high, rugged, rocky hills. The country between the three- and five-mile posts, along the western boundary, and that lying north and northwest of Sanborn lake, is particularly rugged. Rocky hills rise to elevations of one hundred and fifty feet above the surrounding country. A splendid view of the entire township may be had from the hill north of Sanborn lake. South from this point, the country gently rises for nearly two miles, the rise culminating in an east to west granite ridge, which crosses the township from Watabeag lake to the western boundary, about the three-mile post. North and south of this ridge is sand country with low knolls of rock protruding through the sand at widely separated points. Nordica township, excepting six or nine square miles in the northwest, is inferred to be underlain by granite and syenite. The area in the northwest is presumably underlain by Keewatin rocks, as all of the few outcrops seen were composed of hornblende and chlorite schist, metamorphosed sheared basic eruptives of the Keewatin series. These had invariably been cut by numerous narrow dikes of fresh diabase, as well as by a few acid dikes belonging to the Algoman intrusives.

Splendid canoe routes render all parts reasonably accessible. Watabeag lake, which is a feature of the township, has already received mention.

Egan Township

Egan township is one of the subdivided townships of the area. The land in general may be classed as undulating clay loam, except in two or three sections where rocky hills rise to an elevation of 200 to 400 feet above the surrounding country. Fifty to sixty per cent. of the land is suitable for agricultural purposes. The greater part of concession I is unsuitable for settlement, being low and swampy.

The entire township is heavily timbered with large spruce, poplar, balm of gilead, balsam and banksian pine. Much tie timber and some pulpwood have been cut along the Watabeag river. Forest fires in 1921 swept over the northwest quarter, destroying the forest growth.

The Watabeag and Little Driftwood rivers drain respectively the east and west portions of the township. Small creeks tributary to these two streams are numerous. The only lakes seen are in lots 9 and 10, concession VI.

The country along the line between lots 8 and 9, from south to north, is rough. Rocky hills, over one hundred feet above the surrounding country, are numerous. Merriman mountain on the northern boundary immediately west of the Watabeag river is probably the finest point of vantage in the area, being 400 feet high. A splendid view of the surrounding country for miles around may be had; the valley of the Watabeag, winding southward, presents a picturesque setting. Commanding views may also be obtained from Ibsen and Pinero hills. From the summit of the latter hill, a fascinating panorama of wooded plain and gently rolling hills unfolds itself to the east and west, the view south being obstructed by Ibsen hill. The three large hills near the northeast corner of the township are an outstanding feature. The intervening country is a flat woodland with a dense growth of poplar, birch and spruce. Due east, the country appears almost level, broken only by the rocky hills on the eastern boundary of McCann township. To the southwest a rolling succession of round-topped hills and shallow valleys is presented, stretching away as far as the eye can see. A strip of spruce running in a northerly direction marks the course of the Little Driftwood.

The Watabeag river is navigable across the township, but the Little Driftwood, on account of the many log jams, is useless as a canoe route. A good wagon road branches off the main Watabeag Dam road at the forks, near the southern boundary of McCann, and leads to the camps on the banks of the Watabeag river, along the southern boundary and near concession I. A first-class trail leads from the camps on the southern boundary to the Lightning River Gold Mines property in lot 9, concession III. A winter road, which affords a good trail, follows along the Watabeag river to Wasach, on the Temiskaming and Northern Ontario railway, at the crossing of the Watabeag river. On the northern boundary of Egan township, west of Merriman mountain, there is a rock, light to dark greenish-grey in colour. The rock is of porphyritic character, having flesh-coloured phenocrysts of alkali-calcic plagioclase; the rock may be called a porphyrite. The age could not be determined in the field as no contacts were seen. It is tentatively left in the Keewatin, but is probably younger.

Sheraton Township

Time did not permit completing the geological survey of Sheraton. A few sections only were made, which afford some idea of the general aspects of the township, of use to the prospector.

Sheraton township is not very accessible except by canoe in the north, up the Driftwood river from Monteith to Moose lake in Bond township, then south to the lake, along the line between lots 6 and 7, concession VI. Our party entered Sheraton by way of Egan and Timmins townships. These routes are not recommended. In the western third of the township a rolling sand plain area extends from concession I to concession VI. A tract of good agricultural land extends from north to south across the central part of the township. The soil is clay and clay loam.

Near the eastern boundary of the township, the country is rougher, and there are some abrupt rock exposures, particularly in concessions III and IV. The southeast corner of the township is largely Keewatin. There is a contact between the Keewatin and granite near the north boundary of lot 1, concession III. The northeast quarter of the township is underlain with granite. Exposures are most common along the lot 4 and 5 line north from Con. III. According to field notes of W. Galbraith, O.L.S., surveyor in charge of township survey, an abnormally low magnetic declination, varying from 0° to 5° west, was evidenced in the four square miles in the southeast corner of the township.

Michie Township

Michie township is the most rugged in the area, prominent, high rocky hills being found in all parts. The country for a mile east and west of Radisson lake is particularly rough, and rocky hills are of common occurrence. The country lying north of Radisson lake and east of Radisson creek, is sand-covered and appears to have been burnt over about thirty or forty years ago. Small areas of the original jack pine remain.

Along the western boundary the country is level land, heavily timbered with a mixed forest of cedar, birch, balsam, spruce and poplar, of from eight to eighteen inches in diameter. Timber of commercial size is also to be found between Radisson lake and the eastern boundary.

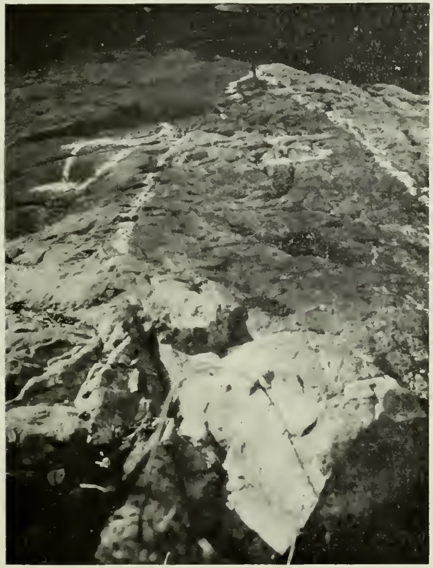
Within the township are several large lakes, Radisson being the largest. The water in Radisson lake is quite clear and in places more than 100 feet in depth. The shore line on the west is all rocky. A precipitous rocky shore, thirty to fifty feet high, extends north from the southern boundary for several hundred yards. It was thought that this shore might possibly represent a fault scarp, with a north to south strike, and that weathering along the fault had produced a valley of which Radisson and the north-to-south string of lakes in Robertson township occupy a part.

The northeast quarter is underlain with Keewatin rocks. Elsewhere the underlying rock formation is largely granite, with the exception of a few patches of Keewatin on the shores of Radisson lake and along the southern boundary of the township. Diabase dikes, usually with a northerly strike, are common, cutting both the Keewatin schists and the Algoman granites.

The canoe route from Stewart to Radisson lake, by way of Macphail lake, is not recommended, as the portages, besides being long, are poorly cut out and lead through considerable swampy country.

Timmins Township

The many lakes in the sand plain country make all sections of Timmins township reasonably accessible. Radisson creek is not navigable by canoes, except for a short distance south from the Nighthawk lake-Radisson creek portage.



A three way contact near the east shore of Saral lake, Timmins township. Fresh diabase, intrusive through Keewatin hornblende schist, and pink weathering hornblende-feldspar porphyry of Algoman? age. The feldspar porphyry is the light colored rock in the upper right hand corner of the picture. Contacts have been accentuated with white chalk.

Radisson creek appears to follow a topographical and geological boundary. All rock outcrops seen west of the creek are granite and those to the east are Keewatin or low knolls of fresh diabase and granite presumably, dike remnants which have resisted erosive influence better than the Keewatin rocks which they intruded. The country lying east of Radisson creek is largely sand-covered, whereas that to the west is low, swampy and covered with spruce. The northern portion of the township is mostly swampy, with minor tracts, ridges and hills of sand. In the vicinity of Island lake the country is more rugged, and several hills rise from one to three hundred feet above the surrounding country. The Saral hills comprise a chain which has a north to south length of three miles, bordering Island and Elspeth lake on the west. The hills consist of hornblende and chlorite schists, liberally intruded by a coarse, fresh diabase together with a few granitic dikes, some of porphyry, of Algoman ? age. The only other rock outcrop of any extent is in the northeast part of the township, where a north-south ridge composed of fresh diabase appears intrusive through the granite at its southern extremity and through the Keewatin at its northern extremity. The dike can be traced for nearly three miles along the strike.

Small, widely separated sections represent the only agricultural lands in the township. They are not of sufficient extent to be of economic importance, even though the township may be more accessible in the future.

Timber resources are average; no large recent brulé areas exist. Jack pine is the principal species represented. Areas of good spruce are situated in the northeast, in the north and in the strip west of Radisson creek. In the more rugged portions there is a very heavy growth of medium-sized timber. Spruce, balsam, birch and poplar are the most abundant species.

INDEX

Vol. XXXI, Part VII.

PAGE

Abitibi Power and Paper Company, Ltd. 2
Abitibi River area 11
Access to area 2, 3
Acknowledgments 2
Actinolite 13
Agricultural land 6, 23, 25, 26
Albite 12, 13
Algoman 11-15
  Fluorite 18
  Granite batholith 12
  Quartz veins 15
Amphibolite 10
Analyses
  Hornblende-albite syenite 13
  Syenite porphyry 12
Andrew lake 23
Ankerite 22, 23
Apatite 13
Assay, gold.
  Biederman claim 21
  Lightning River Gold Mines 21
Azurite 18

Balm of gilead 26
Balsam 5, 26, 28
Bear 5
Beaver 5
Beatty township gold area 1
Biederman gold claim.
  Assays 21
  Diamond-drilling 21
  Notes 21
  Ref. 19
Biederman, William 21
Biotite 11, 13, 21
Birch 6, 11, 24, 27, 28
Black river.
  Drainage area 4
  Refs. 1, 2, 11
  Waterfalls 4, 5
Black tp.
  Cobalt series 15
  Refs. 1 and *n.*
Blackwater lake 2
Blackwater-Lockpot lake route 2
Boundaries of area 1
Brulé 5, 30
Brunnerite 22
Burrows, A. G. 10, 13, 16

Cairo tp.
  Fluorite 18
  Refs. 12, 15
Calcite 13, 22
Canoe routes 2, 6, 24, 25, 26 27
Carbonate 11

PAGE

Cariad lake 3
Caribou lake 6, 23
Cautts creek 4
Cautts lake 4
Cedar 27
Chalcopyrite 18, 19, 21
Chlorite 10, 11, 13
Clay Belt post office 24
Cobalt bloom 19
Cobalt series 3, 7, 15, 24, 25
Cocklin, T. E. 24
Cook tp. 7
Cooke, H. C. 12*n*, 16
Copper 19
Copper-bearing minerals 19

Davis lake 2
De Courcey lake 23
De la Vérendrye 3*n*
Diabase 7
Diabase hill 16
Diamond drilling
  Biederman gold claims 21
Dolerite.
  Explanation of term 10
Dome mill, Tisdale tp. 10
Dougherty, J. W. 2
Drainage areas 4
Driftwood river 4
Dunmore tp. 12, 21

Economic geology 18-23
Egan chutes, McEvay tp. 5
Egan tp.
  Agricultural land 6, 25
  Albite-syenite porphyry 12
  Chalcopyrite 18
  Forest fires 5
  Gold 18, 22
  Granitic dike intrusion 12
  Magnetite 18
  Notes 25, 26
  Timber 26
Elspeth lake 28
Epidote 11
Erythrite. *See* Cobalt bloom.
Extent of Watabeag area 1

Fall Duck lake 19
Feldspar 11, 12, 13, 20
Felsite 20, 23
Fish 5, 6
Forest fires 5, 24, 27, 28
Fort Matachewan 1
Fur-bearing animals 5

PAGE
Galbraith, W., O.L.S. ... 28
Game ... 6
Geological outline ... 6-18
Geological formations (table) ... 7
Goodwin, W. M. ... 2
Gold ... 19-23
Gossan ... 21
Gould ... 19
Granite ... 7
Greenstone ... 9
Greenwood, W. ... 2
Grey lavas ... 11

Height of land ... 1
Holmes tp. ... 12
Hornblende-albite syenite ... 12
Hornblende schist ... 10
Hutchison, F. L. ... 2

Ibsen hill ... 27
Iron ... 18
Iron pyrites ... 21
Island lake ... 17, 28

Jack (banksian) pine ... 5, 6, 23, 24, 26, 28
Joliet (explorer) ... 3*n*

Kaolin ... 11
Kay, George F. ... 1, 2
Keewatin ... 7-11
Keewatin schist ... 10
Kempis mountain ... 22
Kirkland Lake gold area ... 1
Knight, C. W. ... 1, 19*n*

La Salle (explorer) ... 3*n*
Labradorite ... 7
Lake trout ... 5, 6
Lakes ... 4, 25

  Flows ... 7, 8
  Pillow, Playfair and McCann tps. . 8
    Playfair tp. (photo) ... 10
Lee tp.
  Cobalt series ... 3, 15
  Greywacké (photo) ... 16
  Notes ... 24
  Timber ... 5, 24
Legris,—? ... 19
Lemoine lake (photo) ... 25
Lightning River Gold Mines, Ltd.
  Assay ... 22
  Notes ... 21, 22
Link lake ... 6
Little Driftwood river ... 26
Lockpot lake ... 2, 26
Long Watabeag lake ... 6

Macgillivray, J. C. ... 2
Mackay creek ... 4
Mackay lake ... 4
Macphail lake ... 29
Magnetite ... 18
Main Watabeag lake ... 6, 12
Maisonville tp. ... 21
Mapping of area ... 1, 2
Marl ... 5

PAGE
Marquette (explorer) ... 3*n*
Matachewan ... 1
Matachewan area.
  Barite veins ... 18
  Cobalt series slate and quartzite .. 18
Matheson ... 2
Matheson fire in 1916 ... 5, 23
Matheson-Watabeag Dam road ... 23
McCann tp.
  Agricultural land ... 6, 24
  Cobalt series ... 15
  Contact shatter-breccia (photo) .. 14
  Dikes, aplite and feldspar porphyry 17
  Forest fires ... 5
  Granitic dike intrusion ... 12
  Hornblende-syenite porphyry outcrops ... 12
  Keewatin-granite batholith contact 15
  Lava flows ... 7
  Notes ... 24
  Pillow lava ... 8
  Pleistocene ... 18
  Timber ... 24
McDougall, Wasil ... 1
McEvay tp.
  Notes ... 26
  Pleistocene ... 18
  Timber ... 26
  Waterpowers ... 5
McNeill, W. K. ... 12
Mercer,—? ... 19
Merriman mountain ... 27
Michie tp.
  Notes ... 28, 29
  Post-Algoman diabase ... 17
  Schistose granite dike ... 15
  Timber ... 27
Microcline ... 12, 13
Miller, W. G. ... 15, 19*n*
Mobb, Fredrick ... 19, 20
Mobb gold claim.
  Notes ... 20
  Rocks ... 14
Molybdenite ... 19, 20, 23
Monteith ... 26
Moose ... 5
Moose lake, Bond tp. ... 26
Moose river ... 4
Munro gold area ... 1
Munro tp. ... 10

New York ... 21
Nighthawk lake ... 2
Nighthawk drainage basin ... 4
Nordica tp.
  Area in Watabeag basin ... 6
  Forest fires ... 5
  Notes ... 26, 27
  Pleistocene ... 18
  Post-Algoman diabase ... 15
  Schist ... 10

Ontario Land Survey party (1905) .. 19

Phanerite ... 20
Pike ... 5
Pinero hill ... 27

PAGE

Plagioclase ... 12
Pickerel ... 5
Playfair tp.
  Acid volcanoes ... 11
  Agricultural land ... 6, 23
  Gold ... 18, 19
  Lava flows ... 7
  Matheson fire ... 5
  Notes ... 23, 24
  Pillow lava ... 8 10
  Pseudo-conglomerate (photos) ... 8, 9
  Waterfall on Black river ... 4
  Waterpowers ... 5
Pleistocene ... 2, 3, 6, 18, 24, 25
Poplar ... 5, 6, 24, 26, 27, 28
Porcupine gold area ... 1
Post-Algoman diabase ... 15-17
Potter Lumber Company, R. S. ... 2
Pulpwood ... 25

Quartz ... 11
Quartz-albite syenite ... 12

Radisson (explorer) ... 3*n*
Radisson lake
  Acid volcanoes ... 11
  Fluorite ... 15
  Foliated Keewatin schists (photo) 9
  Refs. ... 4, 18, 27
Radisson (Trout) creek, Timmins tp. ... 2, 27
Radisson-Currie lake portage ... 19
Ramore ... 7, 24
Red deer ... 5
Rhyolites ... 11
Roads ... 2, 6, 21, 24
Robertson tp. ... 12

Sanborn lake ... 15, 27
Sand. *See* Pleistocene.
Sanlupe ... 13
Saral hills ... 28
Saral lake, three-way contact (photo) 28
Sarsfield lake ... 24
Schists, Keewatin ... 8, 9
Sericite ... 11
Serpentine ... 11
Sesekinika lake ... 21, 25
Sheba tp.
  Area in Watabeag basin ... 6
  Ref. ... 12
Sheraton tp. ... 4
  Agricultural land ... 6, 28
  Notes ... 28
Soils. *See* Agricultural land.
Sphene ... 13
Spruce ... 5, 25, 27, 28, 30
Stewart lake ... 4
Syenite ... 7, 18

Tabicoe,—? ... 19
Temiskaming and Northern Ontario Railway ... 2, 23, 26

PAGE

Terry tp.
  Area in Watabeag basin ... 6
  Biederman claims ... 21
  Gold ... 18
  Molybdenite ... 19
  Notes ... 25
  Pleistocene ... 18
  Refs. ... 1, 4, 19
Thomas tp. ... 4
Timmins tp.
  Agricultural land ... 30
  Gold ... 18, 19, 21, 22
  Molybdenite ... 19
  Notes ... 29, 30
  Timber ... 30
Timber ... 5, 6, 25, 28
Tisdale tp., rocks ... 10
Titanite ... 13
Titanium ... 18
Tolstoi creek ... 25
Tolstoi tp.
  Agricultural land ... 25
  Area in Watabeag basin ... 6
  Cobalt series ... 15
  Notes ... 25
  Pleistocene ... 18
  Timber ... 5
Toy-Sanborn lake portage ... 16
Tomwood creek ... 3
Trout ... 3*n*, 5, 6
Turkey lake ... 24

Walkerville, Butte, Montana ... 13
Wasach ... 28
Waterpowers ... 5
Watabeag, translation of ... 1
Watabeag area, topography ... 2, 3
Watabeag basin.
  Lakes included in ... 6
  Table of acreages in ... 6
  Townships comprised in ... 1
Watabeag Dam road ... 2, 26
Watabeag lake.
  Depths in ... 6
  Fish ... 5, 6
Watabeag river.
  Refs. ... 2, 4, 5, 17, 27, 28
  Waterpowers ... 5
Water in area, characteristics of ... 3
White Clay river ... 4
White pine ... 5, 6
Whitefish ... 5
Whitefish river ... 4
Wild animals ... 5
Wildgoose lake ... 17, 24
Wildgoose river.
  Refs. ... 4, 5
  Waterpowers ... 5
Wildgoose siding, *See* Ramore.
Wolverton lake, Timmins tp. ... 23

Zircon ... 12

PROVINCE OF ONTARIO

DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES THOS. W. GIBSON, DEPUTY MINISTER

THIRTY-FIRST ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXI, PART VIII, 1922

CONTENTS OF PART VIII

PAGES
Iron Formation of Lake St. Joseph by E. L. Bruce - 1-32
Eastern Part of Lake St. Joseph by E. L. Bruce - - 33-38
Area South of the West End of Lake St. Joseph by E. L. Bruce - - - - - - - - 39-40

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed by CLARKSON W. JAMES, Printer to the King's Most Excellent Majesty
1923

Printed by
THE RYERSON PRESS

CONTENTS

Vol. XXXI, Part VIII

Page

IRON FORMATION OF LAKE ST. JOSEPH

Introductory 1
Field Work 1
Acknowledgments 1
Position, Area and Means of Access.. 1
Previous Work 2
Summary 2
Topography 3
  Local Topographic Divisions 3
Drainage 6
Waterpowers 6
Pulpwood and Timber 6
Agriculture 6
Fish 6
General Geology 7
Pre-Granite Complex 7
Sedimentary Division of Pre-Granite Complex 7
  Description of Rock Types 7
The Iron-Bearing Beds 10
  General Character 10
  Distribution 11
  Origin of Sedimentary Beds 11
  Metamorphism of the Sediments.. 12
  Succession of the Sediments...... 12
  Similar Rocks in Adjacent Areas.. 13
Igneous Division of the Pre-Granite Rocks 13
  General 13
  Acidic Flows 13
  Alteration 15
  Distribution 15
  Origin 16
  Comparison with Rocks in Adjacent Areas 16
  Basic Volcanic Rocks and Associated Schists 16
  Age Relations of the Igneous Pre-Granite Rocks 19
Rocks of the Granite Intrusions..... 19
  Rock Types 19
  Age Relation of the Granite 21
  Glacial Formations 21
  Recent 21
  Geological History 22
Economic Geology 23
  History of Prospecting 23
Iron Formation 24
  Character of the Iron Occurrences. 24
  Mineralogy of the Iron Formation. 24
  Associated and Interbedded Rocks 25
  Origin of the Iron-Bearing Beds .. 26
  Hypothesis of Contact Metamorphism 26
  Hypothesis of Clastic Sedimentation 26
  Hypothesis of Chemical Precipitation 27
  Comparison with Lake Savant Occurrences 29
  Composition of the Deposits 30
  Depth of the Deposits 31
  Possibility of Enriched Lenses ... 31
  Possibility of Concealed Lenses of Magnetite 32
Quartz Veins 32

EASTERN PART OF LAKE ST. JOSEPH.

Introduction 33
Summary 33
Timber 33
Geology 33
Pre-Granite Complex 34
  General 34
  Sedimentary Group 34
  Igneous Group 36
  Granite and Other Intrusives 36
Recent 37
Pleistocene Deposits 31

AREA SOUTH OF THE WEST END OF LAKE ST. JOSEPH.

Introduction 39
Geology 39

ILLUSTRATIONS

IRON FORMATION OF LAKE ST. JOSEPH.

Fig. 1.—Marshy longitudinal valley occupied in part by a bay of Lake St. Joseph 3
Fig. 2.—Hummocky ridges of glacial sands and gravels lying between Lake St. Joseph and Lake No. 1. 4
Fig. 3.—Terminal moraine lakes, north of the narrows of Lake St. Joseph, viewed from a height of 2,700 feet 5
Fig. 4.—Ropy-looking rock of the sedimentary group 8
Fig. 5.—Band of conglomeratic material containing nodules of magnetite 10
Fig. 6.—Photomicrograph of section of quartz porphyry from Island 400, showing absorbed phenocrysts of quartz 14
Fig. 7.—Photomicrograph of quartz porphyry from Island 400, showing feldspar phenocrysts 14
Fig. 8.—Pyroclastic rock on the north side of the narrows, Lake St. Joseph. . 18
Fig. 9.—Photomicrograph of quartz porphyry fragments in pyroclastic rock, north side of the narrows, Lake St. Joseph 18
Fig. 10.—Glacial boulder of granite on the shore of Blackstone lake 20
Fig. 11.—Part of Lake St. Joseph from an altitude of 2,500 feet, looking southwest 23
Fig. 12.—Outcrop of iron formation on Island 84, showing the platey structure formed by weathering in schistose rock 24

EASTERN PART OF LAKE ST. JOSEPH.

Fig. 1.—Photomicrograph × 30 of quartzite from the south side of the bay crossed by the base line between Mile XII and Mile XIV, Eastern part of Lake St. Joseph 35
Fig. 2.—Lake in terminal moraine deposits, south of Lake St. Joseph 36
Fig. 3.—Osnaburgh House, Lake St. Joseph, viewed from an elevation of 800 feet 37
Fig. 4.—Island 670, Lake St. Joseph, showing sand spit formed on the south side 38

GEOLOGICAL MAPS

(*In pocket inside back cover*).

No. 31e.—Western Part of Lake St. Joseph, scale one mile to the inch.
No. 31f.—Eastern Part of Lake St. Joseph, scale two miles to the inch.

IRON FORMATION OF LAKE ST. JOSEPH

By E. L. Bruce

Introductory

It has been known for some years that iron formation occurs at Lake St. Joseph on the Albany river, but as no thorough examination of the deposits for public information had ever been made, and as the region is now fairly easy of access, the writer was instructed by the Ontario Department of Mines to examine the ore deposits and the associated rocks of that region during the field season of 1921.

Field Work

The field work covered a period from the first of June to the middle of September. The shores and islands of the western part of Lake St. Joseph were examined in detail during the first part of the season, and inland traverses were made by pace and compass methods at closely spaced intervals. Along the south shore, owing to magnetic disturbances, it was necessary to use the dial compass; dip needle observations were also made. Small lakes inland from the main lake were located and surveyed by stadia and compass, and the southern part of Blackstone lake, which is included in the map sheet, was also surveyed. Special attention was given to the delineation of the iron-bearing beds. Their possible extension and connections under the lake were determined by dip-needle readings taken by canoe on calm days. In this way it was possible to obtain assurance of the continuity of certain beds. Average samples over considerable widths were taken at some of the more promising occurrences. Some quartz veins were also sampled.

Acknowledgments

Thanks are due to L. G. Williams of the Hudson's Bay Company at Sioux Lookout, to G. B. Murray of Hudson, and to David Wright, in charge of the post at Osnaburgh House, for assistance and hospitality during the field season. J. W. Greig, J. F. Comer, G. L. Fraser, and L. F. Williams, were capable assistants. A large part of the stadia survey made is the work of Mr. Greig, and both Mr. Greig and Mr. Comer assisted efficiently in the geological work. Through the courtesy of Captain A. W. Carter, in charge of the Air Board Station at Sioux Lookout, it was possible to arrange at the close of the field season a flight over the area mapped.

Position, Area, and Means of Access

Lake St. Joseph, practically at the head waters of the Albany river, is on the boundary between the districts of Kenora and Thunder Bay on the south and Patricia on the north. The western end is sixty miles north of the Canadian Government railway at Superior Junction. The area dealt with in this report comprises four townships, three lying west, and one east of the meridian run by J. S. Dobie, O. L. S. in 1919. The southwest corner of the eastern township is at Mile LX on this line.

The area is reached most easily from the Government railways either at Sioux Lookout or at Hudson. From either place the route follows the river to Lac Seul. From Hudson the only obstruction is at Manitou rapids, but the powerful motor-boats used by the Lac Seul fishermen are able to go up or down, except during the spring freshet. From Sioux Lookout there is a thirty-chain portage at Pelican falls before reaching Manitou rapids. The route crosses the eastern end of Lac Seul to the mouth of Root river; thence up that river, which is obstructed by a number of rapids, requiring ten portages. The portage across the height of land which separates Root river from a sluggish stream draining into Lake St. Joseph, is half a mile in length, and much of it is muskeg, across which a pole walk has been made. The route is not a difficult one, as motor-boats can be used as far as the mouth of Root river.

Previous Work

Although Lake St. Joseph has been a main trade route of the Hudson's Bay Company from early times, little mention of it is made in the accounts of early explorers. The first geological literature dealing with the region is the report of Dr. Robert Bell.[1] A transit and micrometer survey had at that time been made by Thomas Fawcett, D.T.S., and this survey is the basis of all the maps up to the present.

In 1900 John E. Davison was attached as geologist to survey party No. 9, and the result of his observation, together with reports by the surveyor in charge, was published by the Ontario government.[2] In 1902 A. W. G. Wilson of the Geological Survey of Canada made an exploration of neighbouring districts, and in his report certain references are made to Lake St. Joseph.[3]

In 1904 William McInnes and Charles Camsell, of the Geological Survey of Canada, crossed parts of Lake St. Joseph on their way to Attawapiskat river and Cat Lake districts respectively, but the country in the vicinity of Lake St. Joseph was not examined by them. In 1919 James S. Dobie, O.L.S., completed a meridian line northwards to Lake St. Joseph, and in 1920 he surveyed the part of the lake west of the meridian and outlined a tier of three townships. A. L. Parsons accompanied the party in 1919 in the capacity of geologist.

Summary

The Lake St. Joseph area is typically pre-Cambrian in character. The topography consists of an irregular hummocky section of small relief developed upon granite, a section of linear ridges upon foliated rocks, and an irregular hummocky section of terminal moraines. The rocks consist of a group of sedimentary origin, with which iron-bearing beds occur, overlaid without any erosion interval by quartz porphyry and andesite flows. These rocks are cut by lamprophyric dikes, granite batholiths and pegmatite dikes. All are of pre-Cambrian age. They are covered in part by glacial and recent deposits.

---

[1] Geol. Sur. Can. Vol. II, Part G. 1886.

[2] Report of the Survey and Exploration of Northern Ontario, 1900, (1901) pp. 230-249.

[3] Report of a Traverse Through the Southern Part of the North-West Territory from Lac Seul to Cat Lake in 1902. Geol. Surv. Publication 1006.

The formations of economic interest are the iron-bearing beds. Channel samples of the most promising lenses do not show a sufficiently high iron content to make them workable without concentration. Concentration tests have not proved encouraging, owing to difficulties encountered due to the fine-grained texture, and to the intimate mixture of hematite and magnetite. Quartz veins occur, but none were found carrying any values in gold. The rock association, however, seems favourable for the occurrence of gold quartz deposits.

At present, fur is the only product of the region. Fish, however, are plentiful and of good quality. Some areas of good pulpwood still remain, but much of the country in the vicinity of the lake has been stripped of timber by forest fires. There are no available waterpowers, but should more water storage be necessary for the Winnipeg river power development, it seems possible that the drainage of the Lake St. Joseph basin could be diverted into Lac Seul.

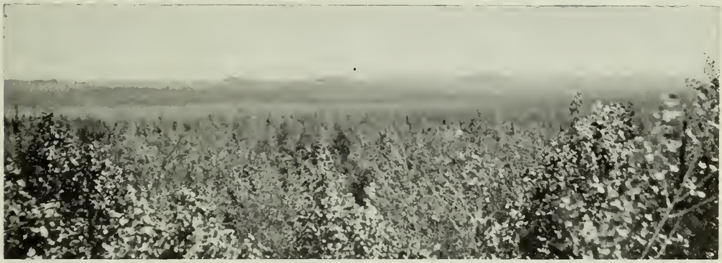


Fig. 1.—Marshy longitudinal valley occupied in part by a bay of Lake St. Joseph. The top of the ridge to the south is glacial sand.

Topography

The area in which Lake St. Joseph lies is part of the pre-Cambrian shield, and its topography is similar in all respects to the general topography of other parts of that region. The surface features of this great geological element have been described so often that it is not necessary to recapitulate those characteristics which are common to all parts of the shield. There are certain local modifications that will be described briefly.

Local Topographic Divisions

In the four townships covered by this report three local topographic divisions are recognizable:

1. The part lying south of the lake in the two western townships.
2. The northwestern part of the two western townships.
3. The two eastern townships.

These divisions do not include the islands. The larger ones, however, belong to the first division.

The Southwest Division.—The southwestern topographic section consists of east-west trending ridges separated by fairly continuous valleys, Fig. 1. Parts of many of the valleys are occupied by narrow bays of Lake St. Joseph, connected to the main lake usually by narrow channels. Other parts of these longitudinal valleys are marshy or swampy, with sluggish streams draining into the heads of the bays. The elevation of the ridges is 100 to 150 feet above lake level.

The linear topography is directly related to the underlying rock structure. The general east-west strike of the almost vertical beds of gneiss, greywacké and quartzite lends itself to the development of straight valleys, either along the softer beds or along lines of structural weakness developed during the folding. Ridges in many cases are formed by massive beds of gneiss or quartzite. The lenses of magnetite are resistant and stand up prominently above the other rocks. A notable example of this is the horseshoe-shaped ridge that forms the lake shore of the southeastern part of Island 84. The marked variation from the usual east-west trend of the ridges is due to the sharp buckling back of the magnetite bed. Inside the flanking ridge a swampy valley parallels the hard layer.

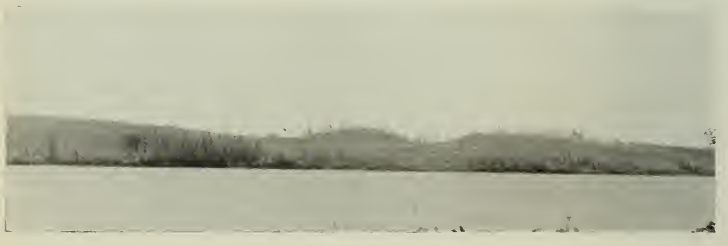


Fig. 2.—Hummocky ridges of glacial sands and gravels lying between Lake St. Joseph and Lake No. 1.

Pegmatite dikes, which are numerous south of the lake, form isolated elevations. As the dikes are not necessarily parallel to the bedding, ridges developed by them do not in all cases conform to the general east-west trend.

The Northwest Division.—Northwest of the long narrow bay north of the main channel of the lake, there is an area of rounded hummocky topography with lakes of irregular outline. The underlying rock is massive granite. The difference of relief is small, since there are no marked differences in rock hardness in the various parts. Although most of the lakes have irregular shore lines and the bays extend in all directions, there are some that have exceptionally long, straight, narrow bays. An especially striking example is the bay of Lake St. Joseph, referred to above. Immediately to the north of it, however, a part of Blackstone lake is joined to the main lake by an equally narrow and straight channel trending at an angle of about sixty degrees to the long arm of Lake St. Joseph. These directions are probably determined by the jointing system of the granite.

The Eastern Division.—The solid rock of much of the inland section of the two eastern townships is concealed beneath glacial deposits. Solid rock is found to elevations of approximately 100 feet above lake level; above that the glacial drift over-burden forms hills as high as 150 feet above the lake. The topography is typical of terminal moraines. There are the characteristic hummocky hills, Fig. 2, among which lie oval lakes, many without visible outlets, Fig. 3. In some places the ridges have a rough southwesterly trend following the direction of motion of the Patrician glacier. Along the lake shore sand beaches extend for long distances. Behind the beaches, banks of sand rise abruptly, in places actually forming cliffs. Material eroded from the sand ridges is carried along the shore by lake currents, and in favourable positions is deposited as sand spits or bay bars. Rather remarkable sand bars have formed across the shore ends of some of the bays, Fig. 3, and behind them marsh vegetation has filled up the shallow water to form great meadows. Some of these marshes drain out through the sand; others have sluggish streams flowing out through breaches in the bar. In some places parts of the lake are separated only by such barriers. The neck of land joining the main part of the peninsula along the meridian line, north of the narrows, consists only of a marsh bordered on each side by sand beaches. It will be noticed from the map that the second pair of bays north of the narrows are actually connected by a water-way, which is passable for canoes even during comparatively low water.

Photograph by courtesy of the Air Board of Canada

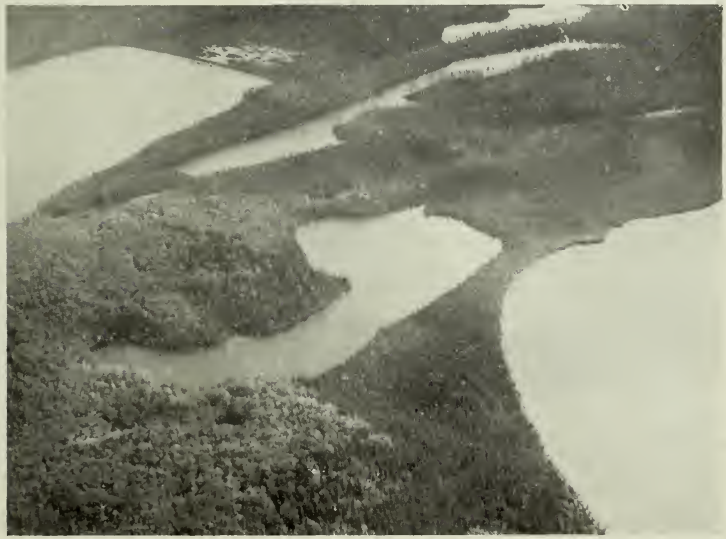


Fig. 3.—Terminal moraine lakes crossed by the meridian north of the narrows of Lake St. Joseph, viewed from a height of 2,700 feet.

Drainage

Lake St. Joseph is the collecting basin for the several small streams which form the head waters of the Albany river. Blackstone lake, which gathers the drainage from a large area to the north, empties into Lake St. Joseph by two mouths. At the west end of Lake St. Joseph a sluggish stream, separated from Root river and the Lac Seul drainage system only by a half mile of low country, flows into the lake. Along the southern shore, the only incoming stream of any volume enters the long southerly-extending bay east of the meridian. This stream receives part of its water from Shekak lake and other lakes lying south of lake St. Joseph and west of the meridian line, and part from a series of lakes east of that line.

Waterpowers

No waterpower can be developed on any of these streams. The fall between Blackstone lake and lake St. Joseph is only two feet, and the volume of water is not large. The other streams are still smaller. Root river has several rapids, but there is not sufficient fall at any one place nor sufficient water to produce a commercial waterpower.

There is a possibility that Lake St. Joseph waters could be diverted to the Root river and Lac Seul basin to increase the water supply for power purposes below Lac Seul. Levels taken across Root portage show that lake St. Joseph is 3.4 feet higher than Root river at the southern side of the portage. The greatest elevation on the portage is less than 25 feet above Lake St. Joseph. So far as can be judged from the surface much of this 25 feet is clay and sand. In any case it would not be a great undertaking to cut through the divide and turn all the lake St. Joseph waters southward to Lac Seul.

Pulpwood and Timber

Fires have destroyed most of the forest growth near the lake in the four townships dealt with in this report. Only one area of fair-sized spruce remains unburned. This lies north of the lake just west of the meridian line. It consists chiefly of spruce, four to eight inches in diameter. A few other small patches of spruce remain in some of the swampy sections. Owing to the sandy glacial deposits much of the original growth was jack pine.

Agriculture

The climate is not too severe for most vegetables and hardy grains. Gardens are cultivated at the Hudson's Bay Company post, on the north shore of Lake St. Joseph, known as Osnaburgh House,[1] but the sandy soil makes it impossible to raise good crops except in wet seasons.

Fish

Lake St. Joseph is well stocked with fish of good quality. The food varieties found are whitefish, pickerel, and pike.

---

[1] *See* illustration, page 37.

General Geology

The rock formations of the area are all of pre-Cambrian age. They consist of sediments and lava flows intruded by granite batholiths. Structurally, they form a syncline of which the northern limb has been entirely destroyed by the igneous intrusions.

The age relations of the various types are shown in the following table.

TABLE OF FORMATIONS

Age	Relations	Rock Type
RECENT		Peat Sand, Clay, Gravel
GLACIAL	*Unconformity*	Pegmatite dikes
PRE-CAMBRIAN		Granite Lamprophyre dikes
	Intrusive Contact	
	Pre-Granite Complex	*Volcanic Group*— Greenstone, Diorite, Chlorite schist, Pyroclastics, Quartz porphyry, Sericite schist. *Sedimentary Group*— Iron-bearing beds, greywacké, quartzite, arkose, biotite gneiss, biotite-garnet gneiss, quartz-hornblende gneiss, sericite and chlorite schists.

Pre=Granite Complex

The pre-Granite Complex consists of two unlike parts, one chiefly sedimentary, the other chiefly igneous. The sediments are highly metamorphosed clastic rocks of the following types—biotite gneiss, biotite-garnet gneiss, hornblende gneiss, arkose, greywacké, quartzite, chlorite and sericite schists, carbonate rocks, magnetite-hematite beds, and magnetite-hematite-jasper beds. There are many gradations between all these, and no one type can be traced for any great distance.

Sedimentary Division of Pre=Granite Complex

Description of Rock Types

The Gneisses.—Although there can hardly be said to be any definite order of rock types, there is in a general way a band of paragneisses—biotite gneiss, and biotite-garnet gneiss—along the southern side of the map sheet, but other rock types are interbanded. The paragneiss is a greyish to brownish weathering rock, containing biotite which marks the foliation. It is distinctly stratified with different layers marked both by differences in colour and in texture. Ordinarily the bandings are less than one-half inch in thickness, but there are some beds as much as five inches thick. Some of the gneisses consist only of quartz and biotite, others have a considerable amount of pink garnet lying in strings along the foliation or bedding. At Station 207, which is south of Island 353, a well banded gneiss has beds up to eight inches in thickness; the colours are grey and brown. Biotite and quartz can be recognized in the hand specimens. Under the microscope the rock appears fairly coarse with quite fresh, interlocking, quartz grains, biotite and sericite. The platy minerals are not arranged in parallel position, and the banding is probably an original characteristic.

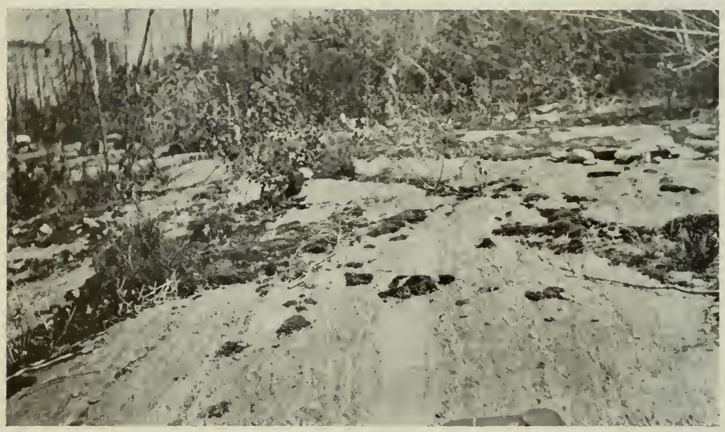


Fig. 4.—Ropy-looking rock of the sedimentary group.

North of the typical paragneiss, but forming a gradational series with it, is a rather remarkable banded rock, with some beds from one inch to three inches in thickness that are similar in all respects to the gneiss. Interlaminated darker bands, however, are made up of chloritic material, and contain gash veins of quartz that begin nearly parallel to the bedding on the north side of the vertical beds, curve across the bed, and in a reverse curve parallel the south side of the bed. They give the rock a peculiar ropy appearance, Fig. 4. Apparently they are the result of the slipping of highly resistant beds over less resistant beds during the folding, with the result that softer, possibly clayey beds between, suffered incipient drag folding. On the eastern point of Island 337 the rocks are very distinctly banded in light and dark grey and brown bands one-eighth of an inch or less in thickness. With these are interlayered crumpled greenish rocks with some quartz stringers. South of Station 136 similar rocks occur. They consist of evenly banded but somewhat granular beds of light brownish grey, interlaminated with schistose, greenish, chlorite rock in which many small gash veins of quartz occur. Some gash veins also occur in the massive layers. One massive bed has a thickness of two and a half feet with many alternations of colour banding. A sample from it under the microscope shows a fine-grained rock with subangular quartz fragments in a matrix made up mostly of iron-stained quartz. It is a somewhat impure quartzite. A sample seven chains inland from Station 13 on the south shore, south of Island 84, comes from an exposure of ropy-looking, rusty rock with quartz gash veins. The thin section shows fresh quartz veins cutting through an iron-stained quartzite.

Quartz hornblende gneiss occurs in the series of sediments on the big point south of Island 407. The greater part of the rocks consists of quartzose or arkosic sediments, but half a mile north of the west end of the narrow bay at the south side of this point there is a band of strongly foliated rock which microscopic examination shows to consist of alternate layers of green hornblende and mosaics of quartz. It is apparently a sediment in which some more richly iron-bearing layers have recrystallized into hornblende.

Greywacké.—The greywackés differ from the gneisses in lack of foliation in the individual beds and the absence of mica or garnet. The rocks are grey and granular. Under the microscope they are seen to be made up of angular to sub-angular and rounded fragments of quartz, orthoclase, plagioclase, and a considerable amount of darker minerals now almost completely altered. A specimen from the sedimentary group on Island 362 is of granular texture not definitely foliated, and contains considerable quantities of dark coloured minerals. The microscope shows the constituents to be sub-angular fragments of quartz, orthoclase, and plagioclase set in a fine-grained matrix.

Arkose.—Many beds of the sedimentary series have a greyish granular appearance. In some outcrops quartz and feldspar are both recognizable in the hand specimen. Under the microscope a sample of rusty-weathering schistose rock from Island 185 shows rounded quartz fragments with altered orthoclase and plagioclase in a finer-grained matrix chiefly of quartz, calcite, and sericite. The rock ten chains east of Station 146 is a finely banded fragmental, with some massive and very hard beds. The sample from these contains rounded quartz fragments with some plagioclase, biotite, and calcite. Many of the rocks associated directly with the iron formation have the composition of arkose; they will be described in dealing with the origin and character of the iron-bearing beds.

Quartzite.—The composition of most of the sedimentary group is largely quartzose. Quartzite and impure quartzite make up much of the rock, and most of the sedimentary gneisses are essentially quartzites in which there is more or less distinct foliation.

Chlorite and Sericite Schists.—In some places the sedimentary rocks have undergone so much deformation that they have been sheared and altered into chlorite or sericite schists. The rocks with considerable quantities of basic minerals have altered into chloritic schists, and the impure quartzites and arkoses have altered into sericite schists. Sericite schists are also formed by the alteration of the quartz porphyry, and basic rocks produce chlorite schists as previously noted. Hence in some localities it is difficult to determine whether the rock was originally a member of the sedimentary group or of the volcanic group.

The Iron-Bearing Beds

General Character

Beds containing large proportions of iron oxide occur near the upper part of the sedimentary group. The iron minerals are magnetite and hematite, in some places interbedded with jaspery material, but ordinarily, with material similar to the fragmental quartzose sediments. The laminated material differs from the usual type of clastic rock in that the greywacké or arkose interbedded with the magnetite or hematite bands contains a considerable amount of carbonate. In some samples the percentage is so large that the rock might with propriety be called a siliceous iron carbonate. So far as seen these carbonate-containing rocks do not occur except in direct association with the iron beds. In many places magnetite or hematite bands occur intimately associated with layers of light pink garnet.

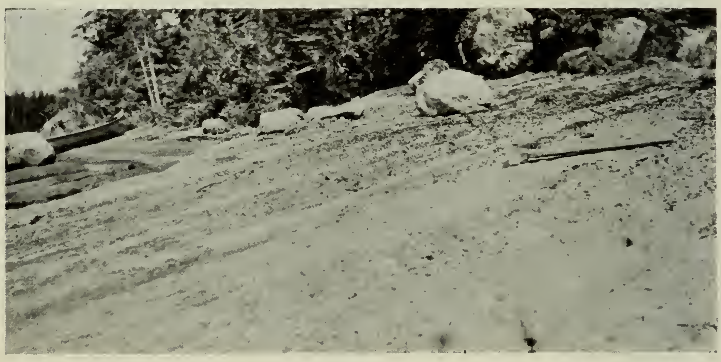


Fig. 5.—Band of conglomeratic material containing nodules of magnetite.

Besides the main bands of solid iron oxides there are certain apparently fragmental rocks of a rather peculiar character. On the weathered surface these appear to be ordinary clastic beds with oval fragments of greywacké, jasper, quartz and magnetite, in a fine-grained ground mass, Fig. 5. The magnetite inclusions are in some cases half an inch in length by two-thirds of an inch in width. The peculiar feature is that the fragments are not nearly equidimensional ellipsoids, but are very much elongated in the vertical dimension, that is, parallel to the original bedding planes. The fragments are thus elongated, cigar-shaped forms.

Distribution

Iron-bearing beds are not confined to any one horizon of the sedimentary series. The thickest and most continuous occur near the northern margin, which for reasons to be given later, is considered to be the upper part of the sediments. There are, however, numerous bands of iron oxides interlayered with sediments far below this main iron-bearing zone, but all these lower bands are thin. All the occurrences are lenticular, and thick lenses may divide into many thinner ones and gradually feather out into normal quartzose sediments.

All the beds stand at high angles, and so the distribution is linear with the exposed width practically that of the thickness of the bed. A very pronounced bed appears on the south shore of Island 84 and forms a well-marked topographic ridge which curves around the southeast part of the island and follows the south shore of the large bay on the east side of the island to its western end, thence northeastward along the northern part of the island and finally bending westward extends southwestward under the lake. Where it next appears it is not one definite bed but several fairly large ones, some of which gradually finger out. Part of this bed, or another lens at about the same horizon, extends along the north side of Island 184 and then westward after buckling sharply northward until it gradually fades out.

Origin of Sedimentary Beds

All the rocks up to and including the iron-bearing beds have been formed under somewhat similar conditions. They are all sedimentary. The bedded character of the biotite gneiss is clearly shown by variations in colour and texture. The beds are of different thicknesses, and of varying mineral make-up. Lines of garnet of the light pink variety, commonly found in sediments, mark the original bedding planes. Staurolite occurs with a similar series farther east, and assuming the identity of the two the presence of staurolite is conclusive evidence of the sedimentary origin of these formations. Near the iron-bearing beds the rocks are typical greywackés and arkoses, in places finely colour-banded and with marked variations of texture across the bedding.

The fragmental beds containing elongated spindle-shaped masses of magnetite offer some difficulty of interpretation. That they are ordinary water-rolled fragments is difficult to believe. An alternative theory of origin suggested is that they represent the accumulation of magnetite grains in the hollows of ripple marks on an old beach. The magnetite-filled hollows were later covered by sand and, after consolidation, the magnetite was changed by compression into solid spindle-shaped bodies. An objection to this theory is the small number of undoubted pebbles that occur in the associated rocks. It seems likely that any beach, where magnetite sands were accumulating, would be well supplied with pebbles. Furthermore, no ripple marks have been observed on any of the bedding planes, and it does not seem likely that all trace of these features would have been destroyed by metamorphism. The production of such bodies during folding by crushing and shearing of the strata has also been considered, but there seems no reason for the localization of this action in these particular beds. Brecciation might have occurred by slumping while the material was still soft.

Another hypothesis is that the elongated magnetite masses were originally hydrated iron oxide concretions, and that they have become dehydrated and indurated during the metamorphism of the enclosing beds.

Although the sedimentary nature of the whole series may be considered certain, it is not clear that all members of it were formed by the same processes. The evidence seems to indicate that the iron-bearing beds have a somewhat different origin than have most of the rocks with which they occur. Probable methods of deposition of the iron formation will be considered in more detail when dealing with the economic geology. As for the gneisses and greywackés, the field observations and microscopic examination all point to a clastic origin. The rocks are peculiar in the almost complete absence of conglomerate or any coarse fragmental material. East of the district under discussion some conglomerate occurs in beds supposed to belong to the same series, but in the section where the chief beds of iron oxide occur no conglomeratic rock, except the peculiar type referred to in the preceding paragraphs, was observed. The original material of the greater part of the sedimentary group must have been fine-grained sands made up mostly of quartz, but, in some layers, with a considerable amount of basic clayey material from which were formed the green and grey chloritic rocks just below the iron bands and the thin beds containing green hornblende. None of the beds are continuous for long distances, but all change in character more or less suddenly along the strike. Conditions of low relief and continental or deltaic deposition must be postulated to explain such formations.

Metamorphism of the Sediments

The metamorphism that the gneisses, greywackés, etc., have undergone has been given in detail in the descriptions of microscopic examinations of the various rock types. It may be summarized here for the group in general. There has been thorough re-crystallization, producing closely interlocking mosaics of quartz individuals in all the sediments. In some of the arkoses the feldspars have undergone change to sericite, and under the intense dynamic metamorphism that has occurred along the limbs of the folds impure quartzites have been rather extensively sericitized, the foils of the secondary mineral being arranged in parallel position; where the alteration has preceded to the extreme, the rock has become a sericite schist. In the gneissic rocks, the foliation is marked by parallel foils of biotite. In some of the biotite and garnet gneisses, biotite shows some alteration to chlorite, and chlorite has formed along cracks in the garnet. Many of the gneisses are somewhat stained by iron oxide.

Succession of the Sediments

It is believed that the younger beds in this series lie to the north, and that sections from the main band of iron formation southward, cross rocks that are descending in the time scale. The strata along the south shore dip northward, but at angles nowhere less than seventy to seventy-five degrees, and hence no conclusion of relative age can be safely based on their attitude. The attitude of the minor folds of the structure is, however, significant. If any bed of the iron formation is followed eastward along its outcrop, it will be found to offset in short folds southward. The pitch of the folds is to the east at angles of forty-five degrees upward. On Island 84 the plunge of the axis is steep to the east. At the offset on the point west of Island 184 it is forty-five degrees to the east. It is evident then, that these beds are on the southern limb of a syncline pitching eastward and hence that strata lying to the southward are nearer the anticlinal axis, and so are lower than the main band of iron formation. Just how far south the anticlinal axis lies has not been determined. An anticline crosses the north end of Shikkagami lake six miles south of Lake St. Joseph, but the gneisses of this anticline are separated from the gneisses along Lake St. Joseph by a belt of intrusive granite which may have destroyed one or more intervening folds.

Similar Rocks in Adjacent Areas

Rocks similar to these sediments are described from neighbouring areas. North of Lac Seul, Burwash[1] mentions banded rocks with which considerable magnetite is associated. He favours an igneous origin for all of them, but they have a marked similarity, as shown by his descriptions, to the metamorphosed sediments in the vicinity of Lake St. Joseph.

Concerning the Lake Savant area, which lies southeast of Lake St. Joseph, Moore[2] makes the following statement: "When the rocks are compared with those of other Keewatin areas, there are a few striking differences. The most noticeable are the great amount of greywacké occurring in the Keewatin, and the presence of considerable amounts of fine-grained grey biotite gneiss, which appears to correspond closely with the gneisses described as Couchiching, by Lawson." Moore considers that part of the gneiss is derived by the metamorphism of quartz porphyry and rhyolite, and part from residual material derived by the weathering of those rocks, but he does not give the evidence upon which he decided that the gneisses are later than the quartz porphyry.

Igneous Division of the Pre-Granite Rocks

General

The igneous rocks earlier than the great granite intrusions are of two chief types, with subordinate variations. These are, (1) quartz porphyry, and (2), basic lava flows. Lamprophyre dikes and massive diorite also occur. The latter rock may be related to the same igneous activity that produced the lavas, or may be due to the re-crystallization of the lavas near the margin of the later granite intrusions.

Acidic Flows

Quartz Porphyry.—The quartz porphyry is a greyish pink or nearly white weathering rock. In some places clear quartz phenocrysts are distinctly visible in the hand specimens, but ordinarily are recognizable only with a lens. Under the microscope the rock is seen to be distinctly porphyritic, with phenocrysts of both quartz and orthoclase set in a fine-grained ground mass.

---

[1] Geological Reconnaissance, Ont. Dept. Mines Rep., Vol. XXIX, Pt. 1, 1920, Page 164.

[2] Ont. Bur. Mines Report, Vol. XIX, 1910, Pt. 1, Page 178, *et seq.*

The character and relationships of the quartz porphyry on Island 400 indicate the character and age relations. On the map the island is shown to be all greenstone, but along the western shore many small bands of porphyry are interlayered with the greenstone. From station 400G at the southwest corner of the island, northward, the following rocks are exposed:—

At station G a narrow band of porphyry, with phenocrysts of quartz and feldspar.

From station G to station A at the western extremity of the point, massive greenstone.

From A north to the bay extending eastward into the island, chlorite schist with a band of quartz porphyry, eight to nine inches wide, along the water's edge on the south side of the bay.

On the north side of this bay, a band of quartz porphyry with good-sized phenocrysts of quartz.

This is followed to the north by a band of chlorite schist, then twelve feet of porphyry with large phenocrysts of quartz, twelve feet of chlorite schist, two to four feet of quartz porphyry, and twenty-five feet of greenstone, schistose in places but showing ellipsoidal weathering, the elongation of the ellipsoids being parallel to the band. At the northwest corner of the island there are other interbandings of quartz porphyry or quartz-feldspar porphyry with greenstone, which in many exposures shows ellipsoidal weathering.

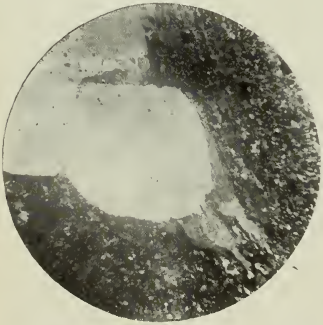


Fig. 6.—Photomicrograph of section of quartz porphyry from Island 400 showing absorbed phenocrysts of quartz. Crossed nicols × 30.

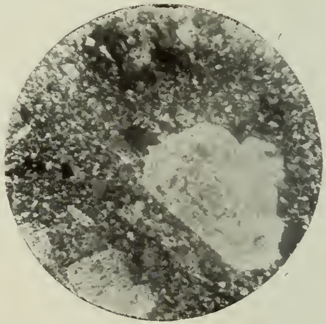


Fig. 7.—Photomicrograph of quartz porphyry from Island 400, showing feldspar phenocrysts. Crossed nicols × 30.

Samples were taken at both sides and at the centre of a band of porphyry twenty feet wide. The texture is found to vary from a dense rock at the south side to a coarse-grained rock at the north side. A similar gradation can be observed in samples from the twelve-foot band listed above. Under the microscope a specimen from the north side of the broader band appears strongly porphyritic, with phenocrysts of orthoclase, plagioclase, and quartz. The quartz crystals show some resorption. The secondary minerals are sericite, calcite, and kaolin. The ground mass consists of small quartz and feldspar grains with a distinct flow structure curving around some of the phenocrysts, Fig. 6. Microscopic examination of a sample from the south side of a band of porphyry of about the same width shows well formed phenocrysts of orthoclase, with some plagioclase. Many of the feldspar phenocrysts show distinct zonal growth. They have undergone considerable alteration to sericite and calcite, and some quantity of these minerals occurs in the ground mass which is mostly fine-grained quartz and feldspar. No flow structure can be noticed, Fig. 7.

The main differences in these samples are the greater number and size of the phenocrysts in the former, and the occurrence of quartz phenocrysts. The largest feldspar crystals are three times the diameter that any attain in the latter specimen, but the ground mass is much finer in the specimen from the north side than in the specimen from the south side. Some of these differences may be due to the fact that the samples are from different occurrences.

Quartz porphyry specimens from Island 250 are distinctly porphyritic, with phenocrysts of resorbed quartz and frayed-out plagioclase and orthoclase in a fine-grained ground mass of quartz with some sericite. The rock on Island 375 is a greenish colour on fresh fracture, but weathers to a faint pink. Quartz phenocrysts are distinctly recognizable in the hand specimen, and the microscope shows well formed crystals of orthoclase and plagioclase. The latter are twinned according to both pericline and albite laws. Much sericite has formed in elongated and connecting strings which have the appearance of flow structure.

From Island 119 grey-weathering altered quartz porphyry with irregular schistosity has rounded phenocrysts of quartz and orthoclase and stout crystals of much altered, but still recognizable, plagioclase. The ground mass consists of quartz and feldspar with calcite, sericite and considerable chlorite. A partial analysis gives SiO_2 66.22 per cent., Fe 5.01 per cent.

The quartz porphyry outcropping on Island 103 is light greenish yellow, with phenocrysts showing distinctly on fresh fractures. The microscope shows the phenocrysts to be irregular quartz individuals which have suffered some resorption and are now surrounded and the cracks in them filled by feathery, secondary minerals. The matrix is fine-grained and indeterminable, but probably consists chiefly of secondary minerals. The rock has been considerably altered.

Alteration

Much of the quartz porphyry shows a decidedly schistose structure both in mass and in the hand specimen. In large masses this structure produces platy weathering. Microscopically, rock from schistoze outcrops shows considerable alteration to sericite, and some samples are practically sericite schists recognizable as quartz porphyry only by a few quartz remnants. Highly quartzose, quartz porphyry may alter into schists very similar to those that are derived from the arkoses of the sedimentary group.

Distribution

Quartz porphyry forms the rock on many of the islands in the large central part of Lake St. Joseph west of the meridian line. It is well exposed on Islands 104, 123, 212 and many others that lie in a belt north of the islands upon which the iron-bearing beds occur. The band is broadest at the eastern end, and bends sharply north in comformity with the fold of the sediments on Island 84. An isolated mass occurs on Island 271. The main band feathers out to the westward in basic flows, and eastward is not definitely recognizable east of Island 84.

Origin

The quartz porphyry is believed to be an acidic lava flow. This conclusion rests on field relations and microscopic evidence. The microscope shows the rock to be fine-grained and porphyritic with distinct flow structures around some of the phenocrysts, Fig. 6. In the field it has been found interlayered with greenstone in relations that seem best explained by assuming that both are effusive rocks. In no place have intrusive relations of quartz porphyry into basic lavas been proved. Concerning relationships on Island 400, detailed previously, Greig, field assistant, wrote the following summary in his notes:

> It would seem that the greenstone and the porphyry were poured out as alternate flows. There is no doubt of the extrusive nature of the greenstone, for there is ellipsoidal weathering. It seems unlikely that the porphyry occurs as dikes, for there are no stringers of porphyry in the greenstone. Measuring across the strike of a series of bands, one-quarter of the exposed rock is quartz porphyry. There is no brecciation; nor are there any stringers of porphyry in the greenstone between the porphyry bands. In some places, porphyry lies between greenstone flows, one of which shows ellipsoidal weathering and the other is massive. If the porphyry were intrusive this relation could occur only if it were intruded along the bedding places between the two flows.

The main quartz porphyry band lies not far north of the northmost bed of the sedimentary group. It is assumed to be younger than the gneiss, greywacké, quartzite, and iron formation on the structural evidence given as to the order of superposition of those beds. It seems to be somewhat earlier than the greater part of the greenstone, but some of the lower greenstone flows are contemporaneous with some of the quartz porphyry flows.

Comparison with Rocks in Adjacent Areas

Quartz porphyries and rhyolites are described in the Lake Savant area by Moore.[1] Concerning them he says: "They are often highly metamorphosed and hard to distinguish from the grey, fine-grained gneiss, some of which has been developed by the metamorphism of these rocks. The quartz porphyries are light grey or pinkish in colour, and often contain distinct phenocrysts of quartz . . . . . They seem to represent the acid phase of the Keewatin eruptions, intrusive and extrusive."

This description can be applied without alteration to the quartz porphyries of Lake St. Joseph, but from evidence cited previously it seems clear that they were later than the gneiss in the northern area, and the gneiss could not have been derived through the shearing of the quartz porphyry or the consolidation of debris formed by its breaking down. It is quite true, however, in the Lake St. Joseph section, as it apparently is at Lake Savant, that sericitic quartz rocks, similar in appearance to the gneiss, are formed by the shearing of the quartz porphyry.

Basic Volcanic Rocks and Associated Schists

The basic rocks, earlier than the granite intrusion, are of four types: (1) Lava flows with which are associated some sediments. (2) Diorites and hornblendites of granitoid texture. (3) Lamprophyre dikes. (4) Pyroclastics.

---

[1] Report Ont. Bur. Mines, Vol. XIX, 1910, Pt. 1, p. 182.

Lava Flows.—The lava are fine-grained, dark green rocks or typical greenstones. In some places they retain the characteristic ellipsoidal weathering of basic flows. Under the microscope they are found to consist entirely of a felt of secondary amphibole and serpentine, with a few remnants of plagioclase feldspar. It is probable that the lavas were of medium basicity, possibly andesites. Some varieties have undergone considerable surface alteration so that, for an inch or more in depth, the rock is distinctly red and quite friable. In other places there is little surface alteration. Some of the massive, rather rusty rock found on the mainland, west of Island 276, is associated with typical greenstone, but was recognized in the field as being possibly of sedimentary origin. Microscopic examination shows the doubtful specimens to be made up chiefly of mosaics of quartz grains that seem to be undoubtedly fragmental. No area of this rock was delimited in mapping, and it is believed that the sedimentary rock is merely a local lens in the volcanic series. Dynamic metamorphism of the lavas has produced some areas of chlorite schist.

Distribution of the Lavas.—The lavas occur along the north side of the main channel of the lake. At the western edge of the sheet a narrow belt of greenstone, lying between sediments on the south and granite on the north, crosses the third meridian at Mile 1. It attains a width of a mile and three-quarters on the main land east of the second meridian, and many of the islands in the bay leading up to the eastern outlet of Blackstone lake are greenstone. North of the lake the extension of the area of rock of this kind is not known. The contact between the granite and greenstone trends nearly due north across the stream between Blackstone lake and Lake St. Joseph. North of Lake St. Joseph, however, the solid rock is concealed in all but a few places by the heavy cover of drift. These outcrops, as far north as the base line, are greenstone.

Diorite.—In the eastern part of the area, well exposed on some of the islands, there is a dark green, or green and white speckled, rock of granitoid texture. Under the microscope a granular rock from Island 6, shows green hornblende, completely altered feldspar, possibly orthoclase, and a little recognizable plagioclase. The association of this rock with granite porphyry, which is described later, makes it seem that the diorite is a hybrid rock formed near the margin of the granite batholith by reaction between greenstone and the intrusive rock. Nearly all the occurrences are not far from the granite-greenstone contact, and there seem to be gradations from fine-textured greenstone to granitoid diorite. On the other hand it is possible that the diorite may represent the interior part of thick basic volcanic flows, or that it may be an intrusive rock accompanying the lava extrusions. No attempt has been made to show the diorite separately on the map.

Lamprophyre Dikes.—Basic dikes cut the quartz porphyry. Most of them are narrow, the widest being not more than eight feet. They weather easily, commonly forming depressions in the hard rock in which they occur, and the surfaces of the dikes are deeply altered to limonite so that it is difficult to obtain fresh samples. Below the weathered portion the rock has a somewhat purple shade. with black hornblende crystals large enough to be visible to the naked eye. Samples from a three-foot dike cutting quartz porphyry on the north side of Island 123, consist entirely of secondary minerals—quartz, calcite, and serpentine—with cubes and masses of pyrite.

These dikes have not been observed in the greenstone, but it is possible that they do occur. The dark colour and conspicuous weathering of the dikes make them noticeable in the hard, light coloured, quartz porphyry, whereas they would not be so readily observed in the somewhat similar dark coloured basic flows.

Pyroclastics.—Some of the quartz porphyry shows a distinct fragmental character with lighter coloured, oval fragments, re-cemented by a somewhat darker material, which, however, is also quartz porphyry. At a locality on the north shore of the narrow channel just west of the meridian, a very striking fragmental rock contains fragments of quartz porphyry with diameters as great as four inches.

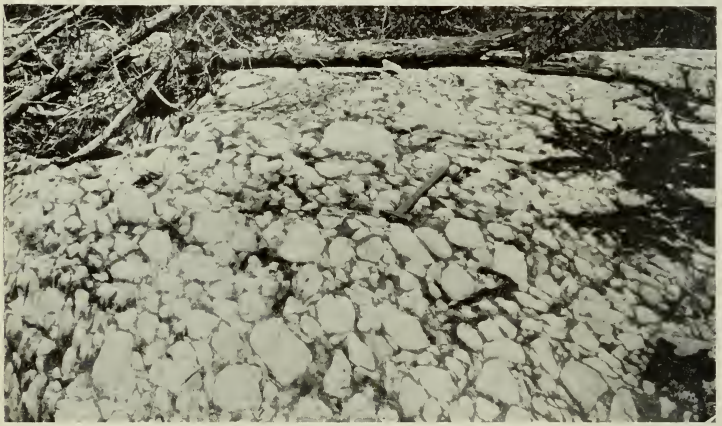


Fig. 8.—Pyroclastic rock on the north side of the narrows, Lake St. Joseph.

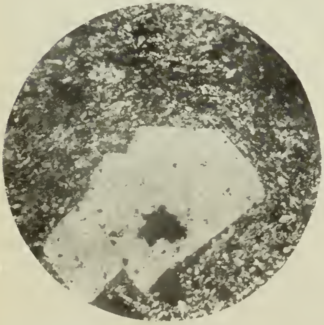


Fig. 9.—Photomicrograph of quartz porphyry fragments in pyroclastic rock, north side of the narrows, Lake St. Joseph. Crossed nicols × 30.

The matrix is dark green chlorite schist, in which the schistosity flows around the fragments. Quartz porphyry makes up the greater part of the rock mass, Fig. 8. A thin section of one of the fragments shows that the rock has undergone very little metamorphism. It is strikingly porphyritic, with well formed phenocrysts of orthoclase in a fine-grained ground mass of quartz and feldspar, Fig. 9; it is a rhyolite porphyry. The undeformed nature of the minerals in the fragments is probably due to the soft and yielding character of the matrix which has absorbed the stresses.

This rock has the characteristics of a clastic rock formed by the breaking up of an early acidic flow during the extrusion of a later basic one. Fragments of the early flow were caught and cemented in the lava, and as the temperature of extrusion of basic flows is not high there was very little absorption of the included fragments.

Age Relations of the Igneous Pre-Granite Rocks

As the sedimentary beds lie on the southern limb of the syncline the younger beds lie to the north. No repetition of formations has been recognized and the axis of the syncline is probably north of the granite-greenstone contact, unless there may be minor folds which are not truncated to a sufficient depth to expose rocks older than the greenstone. Accepting these age relationships, the greater part of the quartz porphyry is earlier than the greenstone. Some sediments intercalated in the igneous rocks were formed during local periods of sedimentation, and the passage from the early period of sedimentation to the period of dominant igneous activity was probably gradational. The diorite bosses and lamprophyre dikes may be intrusive representatives of the same magma that produced the basic lavas, or they may be differentiates or hybrid rocks formed by the intrusion of granite. The whole pre-granite period may be summarized as one of early sedimentation culminating in the deposition of the iron-bearing lenses, and a later period, chiefly of igneous activity, with acidic extrusions followed by basic flows.

Rocks of the Granite Intrusions

Rock Types

Granite Porphyry.—A porphyritic rock occurs on the northeast point of Island 10, and extends eastward across the central of Island 6. Similar rocks outcrop south of this island on the south shore. Field notes with reference to these outcrops are as follows: "The rock is fine-grained and siliceous, with zones or dikes of porphyritic rock in which feldspar forms the phenocrysts. The intrusive relation is not clear, and the porphyry may be a gradation from the diorite with which it occurs. In the centre of the porphyritic mass at the east end of the island it contains partially digested inclusions or basic segregations." Microscopic examination proves that the rock is granite porphyry, with many phenocrysts of feldspar in a fairly coarsely crystalline ground mass of quartz, feldspar, and some biotite. Sericite and other secondary minerals are abundantly developed. This rock is different from the quartz porphyry both in texture and in composition, and is believed to be an intrusive, possibly related to the granite batholiths.

Granite.—Granite occupies or underlies the surface in a large part of the map area. A large mass occupies the northwestern part of the two western townships. The southern border extends nearly east and west across the western township and then curves northward. An embayment of granite extends southward from the northwest arm of Lake St. Joseph as far as Lake 2.

The eastern edge of the granite reaches nearly to the eastern outlet of Blackstone lake. In the southern part of the map sheet, granite outcrops were observed along the first base line, and these were found by aerial observations to be part of a belt of considerable size, which extends southward as far as Shekak lake.

The granite of the northern belt is a very fresh-looking, pinkish variety. A specimen taken at some distance from the contact shows under the microscope a holo-crystalline rock composed chiefly of orthoclase, with some microcline and acid plagioclase. Quartz is abundant, and biotite and a little magnetite are present. The plagioclase has undergone some alteration to kaolin and sericite.

The granite is intrusive into greenstone, and dikes are numerous in the greenstone near the margin. The granite shows little internal evidence of the intrusion, and is practically unaltered right up to the contact; no foliation is developed in it as is the case near many greenstone-granite contacts. In the southern belt there are more evidences of reaction between the granite and greenstone, and, in places, there is some foliation.

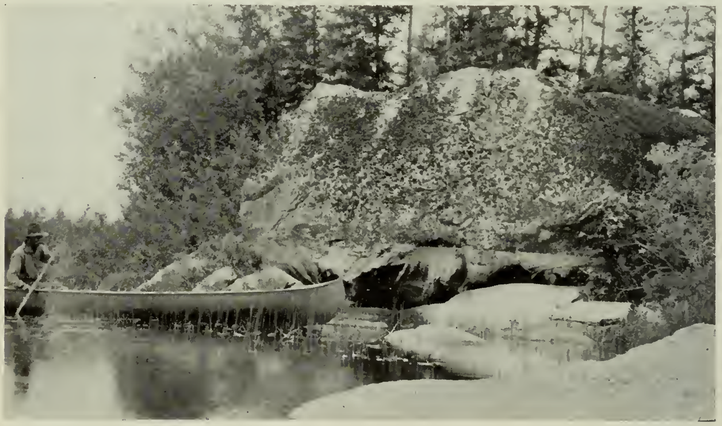


Fig. 10.—Glacial boulder of granite on the shore of Blackstone lake.

Pegmatite Dikes.—Pegmatite dikes are developed very abundantly in the gneiss along its southern margin. In general, they consist of pink feldspar and white quartz with considerable muscovite and some biotite. In many of them black tourmaline has crystallized out along the margins. One crystal of beryl was found. The pegmatites are no doubt related to the granite intrusion to the south. It may be considered an additional indication of the structure of the region that the dikes occur abundantly near the southern granite mass, less abundantly in the northern part of the sedimentary area, and that few are found along the northern border of the gneiss, even where the distance to the northern granite mass is not great. No typical pegmatite was found in the greenstone.

Age Relation of the Granite

The granite is the youngest pre-Cambrian rock of the region. It is much later in age than the other pre-Cambrian rocks, the sediments having been laid down and consolidated and the lavas poured out and solidified long before the batholithic invasion. The granite was associated with the regional disturbances that produced the close folding. Great thicknesses of overlying formations have been removed to expose the granite cores of these early mountain chains.

Glacial Formations

In this region there are no rocks belonging to the long period of time between the pre-Cambrian and the Pleistocene. If any such ever existed they have been completely removed by erosion. The formations of the Pleistocene are unconsolidated glacial deposits, chiefly of sand, containing some boulders, and only a small quantity of clayey material. In the areas underlaid by granite the prominent jointing provided conditions for easy removal of large rock masses by the moving ice, and some immense boulders are found along the shores of Blackstone lake, Fig. 10. These have not been moved any great distance.

Glacial erosion is well marked along the lake shore where fresh rock surfaces are exposed. The gneissic rocks have not retained many evidences of glacial action, but glacial striæ are visible on many of the granite surfaces. The signs of glacial erosion are not as abundant or as striking as they are in many sections of the pre-Cambrian shield, and it seems likely that, for long periods the ice was almost stagnant, and that this area was the site of dedeposition, rather than of extensive erosion. This is borne out by the typical terminal moraine character of the glacial deposits. Wherever glacial striæ were observed, they have the southwest trend of the Patrician glacier.

The surface upon which the glacial deposit rests is remarkably fresh. Differences of relief are small. The fresh pre-glacial surface with comparatively small differences of relief even in heterogeneous rocks, could not have been produced by the comparatively weak erosion of the Pleistocene ice. It was no doubt formed long before that time. There is no evidence in this area to fix the date of the planation, but it was probably pre-Paleozic, as has been shown to be the case in other sections of the Canadian shield.[1]

Recent

Since the glacial period the chief changes are the rearrangement of the glacial deposits and the growth of peat bogs in undrained areas. Along the lake shores the ridges of sand and gravel are being continually cut into by the waves. The eroded material is carried along the shore by the currents and deposited as sand bars and spits. These have been discussed in a previous paragraph. Peat bogs are not extensive. Where gneiss is the underlying rock, swampy country may extend for considerable distances parallel to the structure, but such areas are narrow. So much of the glacial material is sand that there is fairly good drainage wherever the solid rock is covered with glacial deposits. Marshes border some of the lakes and the sluggish streams.

---

[1] Memoir 105, Geol. Surv. Can.

Geological History

The geological history indicated by the formations just described begins with an early period of ordinary sedimentation in a country of comparatively low relief, so that the sediments consisted chiefly of sandy material with practically no coarse fragments. At various times conditions in restricted basins were favourable for the accumulation of iron-bearing beds. The area affected by these conditions was small, and the time during which they existed was short during the early part of the sedimentary epoch, but towards its close large areas of this kind existed for periods sufficiently long to form beds of iron minerals some hundreds of feet in thickness. The conditions of deposition of these sediments, high in iron, will be dealt with in more detail later.

After the deposition of the main iron-bearing beds came the beginning of volcanic activity. The first lavas extruded were acidic in character and comparatively small in quantity. The later acidic flows alternated with basic lavas, and finally only basic lavas were poured out. Many of the basic flows have typical ellipsoidal forms which are usually assumed to be the result of extrusion under water. Along with the volcanic effusions there were formed some ordinary clastic sediments, probably in local basins.

The extrusion of the lavas, possibly accompanied by the intrusion of deep-seated rocks of similar composition, closed the first great epoch of geological history. It was followed, after the lapse of sufficient time to thoroughly consolidate the clastic rocks, by intense disturbances, which threw the formations into closely appressed east-west folds pitching to the east. These disturbances were accompanied or followed by the intrusion of igneous rocks. Great batholithic masses of granite welled up along the axes of the folds, intensely metamorphosing and disturbing the overlying rocks. Narrow lamprophyre dikes are evidence of igneous activity, the age of which is not definitely known; they may belong to a pre-granite period, but their undeformed character indicate that they may be differentiates in some way associated with the granite. Pegmatite dikes mark the closing period in the consolidation of the granite.

After the igneous intrusion and the structural deformation with which it is associated, there was an immensely long erosion interval in which the heterogeneous early rocks and the granite were cut down to a fairly level plane which, it is believed, did not differ very greatly in appearance from the present solid rock surface. No rocks of any age between the pre-Cambrian and Pleistocene remain, but assuming that this portion of the Canadian shield has the same general history as other parts of its southern edge, it is likely that Paleozoic and possibly Mesozoic formations at one time covered part, if not all, of the pre-Cambrian rocks. If these later formations did exist, they were completely removed before the advance of the Pleistocene glacier. The chief work of the Pleistocene glaciers was the removal of unconsolidated and weathered debris from solid rocks. Later, the stagnant ice front permitted the deposition of immense quantities of largely unassorted glacial debris. Since the ice age there has been some rearrangement of the glacial sands and gravels and the formation of organic deposits. These processes are going on at the present time.

Economic Geology

History of Prospecting

The chief economic interest in the Lake St. Joseph country is in the beds of iron oxides. It seems strange that though the beds are close to the main route of travel, followed by the Hudson's Bay Company brigades and all other travellers down the Albany river, no one mentions actually having seen iron-bearing beds. Even the early geological report of Dr. Bell[1] does not mention such an occurrence, nor does the writer note any abnormal local magnetic attraction. In the report of the geologist attached to the Ontario Exploration Party No. 9, the following note is made.[2] "At sixteen miles (from Root portage) chlorite or hornblende schist occurs along the shore. An area of great magnetic variation extends for ten miles down the schist; no apparent cause was found as the adjoining schist showed no traces of magnetite. At one point the variation was 65°." It is possible that the schist which showed no magnetite was that along the south shore south of Island 84. The magnetite occurrences are on the south shore of the island and bend back to the east beneath the channel separating it from the south shore. These beds under the lake attract the needle all along this passage although exposed only on the islands, Fig. 11.

Photograph by courtesy of the Air Board of Canada

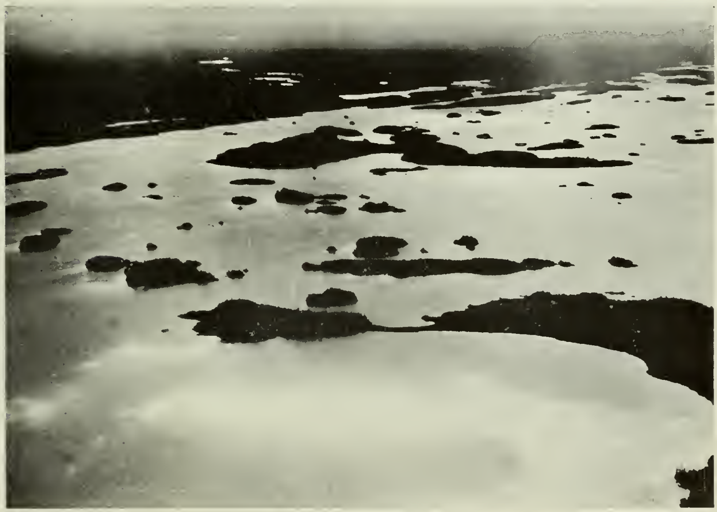


Fig. 11.—Part of Lake St. Joseph from an altitude of 2,500 feet, looking southwest. Island 84 is the irregular island in the centre of the picture. Island 162 is the long island beyond Island 84 near the south shore.

---

[1] Annual Report Geol. Surv. Can. New Series, Vol. II, 1886.

[2] Report of the Survey and Exploration of Northern Ontario, 1900, p. 249.

Some of the men connected with the Hudson's Bay Company posts along the Albany river knew of the deposits and claims were staked by Jabez Williams, formerly in charge of Lac Seul post, now at the post at Fort Hope on the Albany. Chiefly through his enterprise a diamond-drilling outfit was sent in from Port Arthur. Island 162 was chosen as the place for testing the beds, and a considerable amount of drilling was done. A hundred feet or more of drill core still remain in the cabin on the island, and no doubt the better portions were taken out for assaying. The walls of a cabin apparently belonging to prospectors of an earlier period are still standing on Island 84, but the only trace of development work found was a few clearings near some of the outcrops.

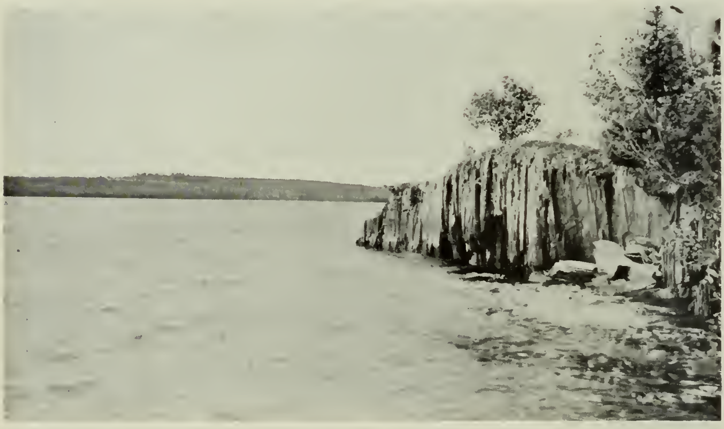


Fig. 12.—Outcrop of iron formation on Island 84, showing the platy structure formed by weathering in schistose rock.

Iron Formation

Character of the Iron Occurrences

Although the iron oxides are associated with sediments and form part of a great sedimentary series, the actual occurrence of the bodies of iron oxides is lenticular in character. Due to folding, various parts of the same lens have undergone different degrees of metamorphism, and hence what were originally similar portions of the lens, are now somewhat unlike both in physical and mineral make-up.

Mineralogy of the Iron Formation

The minerals in the iron layers are not of great variety. In the contorted beds at the crests of the folds, the iron is almost entirely in the form of magnetite, interlaminated with some quartz, but chiefly with lenses of rock material of varying thickness. Along the limbs of the folds where the movements of the beds with reference to one another was greatest, there is usually little visible foreign material, and the whole lens appears to consist of strongly schistose magnetite, Fig. 12, and specular hematite, which is in many cases micaceous in structure. On microscopic examination and chemical analysis it is shown, however, that there are quite large proportions of silica mixed with the apparently pure iron oxides. No apatite or titaniferous minerals have been recognized either on polished surfaces or in the ground minerals, but the analyses of samples from different localities all show considerable quantities of phosphorus and traces of titanium. Small, transparent, deep red garnets, with sharp crystal outlines, were found embedded in magnetite from the eastern part of Lake St. Joseph. The crystal form is the unmodified rhombic dodecahedron.

Associated and Interbedded Rocks

The rocks associated with the iron oxides are all clastic, most of them with a high percentage of silica. The following petrographic descriptions are of the various rocks interbedded with, or in direct contact with, lenses of iron oxides.

A specimen of rock lying between bands of iron oxide on Island 84 consists chiefly of carbonate with some chlorite and many rounded grains of quartz. A partial chemical analysis shows SiO_2 40.04 per cent., and iron 7.02 per cent. The carbonate does not effervesce with cold acid and so is probably dolomite or ankerite. At the southeast corner of the same island rock material is interlaminated with iron oxide, jasper, and quartz. A specimen of the rock under the microscope appears fine-grained and highly siliceous, with the quartz recrystallized into mosaics. Well-crystallized magnetite is present, commonly associated with chlorite. Biotite and sericite are abundant, and the foils are in parallel position. A specimen of rock from the iron-bearing beds of the north part of the same island has rounded fragments of quartz with some orthoclase and plagioclase. The ground mass is schistose consisting of sericite. Biotite is present as well, but the foils are not parallel to the schistosity, and it may have developed subsequent to the foliation. On Island 98 a yellowish green, granular rock lies north of a band of fragmental or nodular iron oxides. The rock appears distinctly foliated under the microscope, and consists chiefly of rounded quartz grains that show secondary enlargement, and some plagioclase. A partial analysis shows silica 72.3 per cent., and iron 6.32 per cent.

Rock occurring near the iron beds on the north side of Island 133 consists of a few larger particles of plagioclase of fairly acid character, which look like phenocrysts. The finer material is mostly quartz and fragments of plagioclase with considerable secondary quartz and some calcite. The origin of this rock is somewhat doubtful. The field evidence seems to show that it is a fragmental rock, possibly a greywacké, but under the microscope, it has some of the characteristics of a sheared igneous rock.

Well-banded rock noted on Island 158 contains some narrow bands of magnetite. The widest is not more than two and one-half inches. Microscopically, the rock appears granular, with large rounded or subangular quartz individuals showing secondary enlargement, set in a ground mass of finer texture which is mainly quartzose but contains some calcite and epidote. Many of the largest quartz fragments show strain shadows and others have been actually fractured, and the cracks filled with the finer material of the matrix. The rock is apparently an arkose which has been rather severely sheared.

Origin of the Iron-Bearing Beds

The descriptions given above show that the beds containing magnetite and hematite are interlayed with typical sedimentary beds differing from the ordinary sediments, not directly associated with iron-bearing beds, only in that they carry considerable amounts of carbonates, probably of iron. There are also some beds of conglomeratic character in which nodular masses of magnetite are found. From this association it might be assumed that the iron minerals are sedimentary in origin, but before accepting this conclusion definitely other hypotheses of the origin of bedded magnetite deposits should be considered. The following are possible methods of formation: (1.) Contact metamorphism. (2.) Clastic sedimentation. (3.) Chemical precipitation.

Hypothesis of Contact Metamorphism

Contact metamorphism has been established as the probable method of origin of many bedded magnetite deposits. The ores of such deposits are usually coarse in crystallization, and the magnetite has associated with it typical contact metamorphic minerals such as garnet, epidote, and usually pyrite. Deposits in bedded rocks may follow certain favourable beds for long distances, but they are more likely to be rather irregular. It is usually the case that contact metamorphic deposits are fairly close to igneous rocks which have supplied the conditions necessary for re-crystallization, and which have in most cases furnished part of the material for the deposits.

The Lake St. Joseph deposits are distinctly bedded, but are lenticular. Each bed is confined to a certain horizon, and gradually feathers out into non-iron bearing rocks. The change does not seem to be the result of any variation in an original bed producing less favourable conditions for replacement. In the carbonate-bearing rocks the iron is contained in the carbonate. It is not a replacement of carbonate by magnetite. Contact metamorphic minerals are not common in the iron-bearing beds. Garnet is found in some samples of magnetite, but it has the appearance of crystallization from impurities contained in the magnetite, and does not seem to have been formed by additions from an outside source to the minerals of a pre-existing formation. The garnet does not occur as zones or masses, but only as scattered, well formed crystals.

The granite is the only great intrusion in the area. If the iron formation were of contact metamorphic origin, it would be expected to occur fairly close to the contact of the granite batholith with the older rocks. The main beds of iron oxide occur in the district mid-way between the two great granite intrusions. No magnetite bands were found anywhere near the northern granite belt, and there is no marked local attraction in that section. On the south shore of the lake some magnetite bands occur in the gneisses between the main magnetite band and the belt of granite: none of these is of large size and the lenses become less numerous and smaller in size proceeding southward. From these facts it is concluded that the iron formation is not of contact metamorphic origin.

Hypothesis of Clastic Sedimentation

The occurrence of bedded deposits of iron oxides interlaminated with clastic sediments would seem to be most simply explained by assuming that the magnetite was laid down with the other sands, as it sometimes accumulates along modern beaches. There are several features, however, which do not seem to agree with this theory. The magnetite of the Lake St. Joseph deposits is fine-grained, and the grains are not rounded or flattened but quite angular. Much of the angularity is no doubt due to re-crystallization, but it seems doubtful that all the original rounded grains of magnetite would have been re-crystallized into angular ones. In the second place, a clastic deposit would contain not only magnetite and quartz, but other heavy minerals that occur along beaches, such as garnet, titanite, apatite, etc. Garnets occur in the magnetite as noted previously, but only rarely and then as sharp, well-formed crystals, not as rounded grains nor as lenses as might be expected if the garnet were detrital. Titanium occurs only as traces in any of the ores analyzed, and hence the heavy and resistant titanium minerals, which are present in most sand deposits, are almost entirely absent. If the iron formation and the interlayered greywackés, arkoses, and gneisses are all clastic, then all the beds might be expected to contain considerable amounts of magnetite as water-rounded grains. Magnetite does not occur abundantly in any but the main beds, and there are no intermediate types between the lenses of high iron content and beds practically without magnetite, with the exception of those conglomeratic beds, in which the magnetite looks like rounded pebbles but is actually in the shape of flattened cylinders or spindles. The explanation that has been offered for these is that they may be concentrations of magnetite sand in ripple marks, but from the character of the grains they are more likely concretionary. Finally, the small included lenses of rock, which consist largely of carbonate, are evidence that different conditions prevailed during the deposition of the iron-bearing beds from those present during the formation of the other sediments. Jaspery lenses are further proof of this, although jasper does not occur in large quantity.

Hypothesis of Chemical Precipitation

The theory of formation by chemical precipitation explains the characteristics of the ore more satisfactorily than do the preceding hypotheses. It explains the fine-grained character of the oxides, the association with jasper and iron carbonate, the absence of heavy detrital minerals scattered through the ore, and the scarcity of magnetite in beds other than the main iron-bearing members. Assuming that chemical precipitation was the mode of formation, various conditions of deposition may have obtained. The original minerals may have been iron silicates or iron carbonates, as is held for many of the Lake Superior iron deposits; the original mineral may have been hematite, as in the Clinton ores; or the iron may have originally separated as hydrated iron oxides.

In the Lake Superior region, the deposition of iron-bearing minerals is believed to have been preceded by the effusion of basic lavas beneath the sea, so that the water became saturated with iron salts. From this sea of abnormal chemical constitution and probably fairly high temperature, iron silicates such as greenalite were deposited. Later, under ordinary weathering conditions, the silica was leached from the greenalite in favourable localities where there was a concentration of the ground water along certain channels. In this way the iron oxides were left as enriched residual material along the axes of synclines or in structural basins of other types.

That such conditions did not exist at Lake St. Joseph is shown by the following facts. No iron silicates have been recognized in any of the sections examined. It is possible that they may have been overlooked, or that the samples collected did not happen to be from the proper locality, but the microscopic examination is borne out by the low iron content in the sediments, and the samples are fairly representative of the various beds. The lenticular character of the Lake St. Joseph deposits is original, whereas the lenses of the Lake Superior region are due to secondary leaching, usually at the axes of synclines. The lenses of magnetite at Lake St. Joseph are not synclinal but, neglecting the minor folding, they lie along the limb of a major syncline. Hence they are not structural features formed after the folding, but were prior to it and probably original. If so, there seems to be no reason to suppose that they are alteration products from a bed of iron silicates unless such a bed be assumed also to have been lenticular. Finally, the basic lavas in the vicinity of Lake St. Joseph are above the iron formation and, being later, could not have supplied their iron content. It is possible that flows contemporaneous with, or earlier than, the iron formation, may have existed in other districts sufficiently near to have supplied the iron solution for the Lake St. Joseph deposits. They did not exist beneath the gneisses and arkose of the local sedimentary series, for in that case the iron formation would have been at the base of the series instead of near the top. Thus, the absence of iron silicates, the original lenticular nature of the magnetite beds and the absence of earlier basic lavas which might have supplied iron solutions, are indications that the iron formations were not directly derived from subaqueous lava flows.

The Clinton beds are believed to have formed by the direct precipitation of hematite in sea water. As there is a considerable quantity of hematite with the magnetite in some of the occurrences at Lake St. Joseph, it might be assumed that they were originally deposited as hematite and later altered to magnetite during the deformation of the region. On such an assumption the most complete alteration to magnetite should occur in those places of greatest compression and movement. The opposite condition is found. At the crests of the minor folds, the iron is chiefly in the form of magnetite, and along the limbs where the greatest differential movement has occurred a large proportion of specular hematite is found. From theoretical considerations it is doubtful if hematite would be altered to magnetite by regional metamorphism. It would appear that the elimination of oxygen should reduce the volume and hence that hematite should alter into magnetite under compression. There is, however, a difference in specific gravity between specularite and magnetite sufficient to off-set this and to make it more probable that, under pressure alone, specularite and not magnetite is the stable oxide. This agrees with the field evidence.

A third mode of origin to be considered is deposition as hydrated iron oxides or as carbonate. Hydrated oxides are commonly deposited at the present time in bogs receiving the drainage from iron-bearing rocks. Such an origin would explain the lenticular character and the freedom from detrital material in the iron minerals. It would also explain the spindle-shaped magnetite masses in the conglomeratic beds. There is, however, a question whether iron carbonates or hydrated iron oxides would be precipitated without organic agencies, and these, if present at all, were probably not abundant at this early period. Aside from this possible theoretical objection, the above hypothesis explains most satisfactorily the observed facts, and as it does not seem impossible that these minerals can be formed by chemical action alone, this is concluded to be the method of formation of the original iron-bearing beds. The history of the deposition may be summarized as follows. There were certain basins in the old land surface at various times in which iron-bearing solutions obtained by the ordinary weathering of the surrounding rocks were collected, and from these solutions iron hydrates or iron carbonates were precipitated. Occasional periods of flood brought in some clastic material, now found as lenses of rock. At the edges of such basins this was most common and so the fingering out of the iron ore lenses into iron-bearing clastic rocks is explained. The abundance of iron beds, and the greater thickness near the top of the sedimentary series, may have been the result of longer periods of deposition, or possibly of the beginning of volcanic activity in some district tributary to the basins of precipitation. It is not believed that carbonates formed a large part of the original beds, for the amount of carbonate found at present is small, and it does not seem to have undergone much alteration to oxides. The change from hydrated oxides to magnetite and hematite could easily result through the regional disturbances. The form of the oxide would depend upon local conditions.

Comparison with Lake Savant Occurrences

Iron formation which occurs at Lake Savant has been examined by E. S. Moore. His conclusions are similar in some respects to those reached for the Lake St. Joseph occurrences. Judging from Moore's descriptions the Lake Savant occurrences have a larger proportion of jasper to iron minerals. Concerning the genesis of the iron oxides Moore says:[1]

> There are, no doubt, plenty of igneous rocks in the region to supply the ore, but their relations to the jaspers do not seem to indicate them as the source. Instead of the igneous rocks being interbanded with the iron formation, the latter is made up of large quantities of greywacké, evidently derived from the partial decomposition of the igneous rocks. If the igneous rocks supplied the iron solutions to the seas there should be greater regularity in the distribution of the iron formation, a smaller proportion of imperfectly water-worn sediments, and a closer relation between the igneous rock and the jasper. For the Savant region it appears that conditions favour deposition in bodies of water of limited size and surrounded by land areas capable of furnishing the material for the greywacké. The source of the iron must have been chiefly the igneous rocks which were decomposed, supplemented to some extent by solutions supplied directly to the bodies of water by heated igneous rocks. The iron formation must have reached its present condition through extensive metamorphic processes by which rearrangement of the iron and silica took place, emphasizing the banded formation and changing chert from a crypto-crystalline to a granular crystallized mass . . . . . The earliest iron compound, the remains of which may still be recognized, seems to have been the carbonate, which is now very largely altered to magnetite by excessive metamorphism, while the quartz seems to have originally been in the form of chert.

There are some conditions in the deposits of the Lake St. Joseph area that do not fit, exactly, the hypothesis suggested by Moore. The igneous rocks are later than the iron beds, and so could not have supplied even a part of the iron solutions directly, nor could their decomposition have furnished the debris for the greywackés. The earliest rocks exposed are clastic sediments, and the source of supply of the constituent minerals is unknown. There seems to be no reason to assume that the crystallized quartz with the iron beds at Lake St. Joseph was originally cherty. It was probably ordinary sand interbedded with the original iron minerals and later altered into mosaics of interlocking quartz individuals. Some carbonate has been found with the magnetite-hematite beds, but there is no evidence that all the iron, or even any large amount of it, was originally in the form of carbonate. In fact, the carbonate in the samples examined has more the appearance of being itself secondary. Aside from these points, the explanations offered for the origin of these similar beds in the two adjacent areas are practically the same.

---

[1] 19th Annual Report, Ont. Bur. Min., 1910, Pt. 1, page 189.

Composition of the Deposits

The fine-grained character of the magnetite conceals much of the foreign material which it contains. At the axis of the folds there is a considerable quantity of interbedded quartz, jasper, and rock, but along the limbs, the beds have been sheared into tabular blocks which consist of magnetite with enough specular hematite to give a red streak, but no other minerals are recognizable in the hand specimen. It is found on crushing that there is a large amount of gangue, mostly silica, even in the best samples. Specimens can be chosen which give a fairly high content of iron. In attempting to estimate the value of the lenses, portions were selected which seemed to be of good grade and which were also sufficiently large to give workable tonnages, if the content of iron should be found to be sufficiently high. Chipped samples were taken across such outcrops, and the following results may be considered to be averages of some of the most promising occurrences.

	14	15	134	135	165	172	173
Fe	32.60	34.94	38.42	36.32	34.4	37.7	37.92
S			none	none			none
P			0.1209	0.1564			0.2305
Ti			trace	trace			trace

No. 14. Channel sample across 15½ feet at the south side of the iron-bearing band along the northwest side of Island 84 at a point opposite Island 131.

No. 15. Channel sample across 16½ feet of the north side of the iron-bearing band at same locality as No. 14. The two samples are continuous, making the total width sampled 32 feet.

No. 134. Channel sample from the ridge of iron formation north of station C on the south shore of Island 84. Width of the beds at this point is 375 feet. The size of the individual outcrop where the sample was taken is 50 feet by 200 feet. Width sampled 30 feet.

No. 135. Channel sample across a width of 25 feet parallel to number 134, and thirty feet east.

No. 165. Channel sample across 35 feet of iron formation high in magnetite, two chains inland from station C, Island 84. This outcrop is much contorted and contains considerable jasper.

No. 172. Channel sample across 40 feet of iron formation north of the cabin on Island 162.

No. 173. Channel sample across 32 feet of iron formation at the same locality as No. 172. The south end of sample 173 is 25 feet north of the north end of 172. The two samples make a total width sampled of 72 feet but 25 feet of lean rock between the ends of the two channels was not sampled.

A report by Prof. S. N. Graham, of mill tests made on two samples of ore, at the mining laboratories at Queen's University, is as follows:

> The ore consists of a very fine-grained and intimate mixture of magnetite, hematite and silica. Preliminary tests showed that very fine grinding was necessary to make any separation of the iron minerals from the silica. Tests were then made by wet magnetic concentration on a drum machine of the Gröndal type. In making the tests the tailings were re-run, and concentrates produced were added to those made in the first run. The sand tailings contained a small amount of weakly magnetic material, which probably consisted of grains partly of magnetite and partly of hematite. The overflowing slime was of a deep red colour, due to the hematite.
>
> The following are the results of the tests:—

Sample No.	Analysis of Iron ore	Degree of grinding, through 200-mesh	Analysis of concentrates Iron	Ratio of Concentration	Total Iron Recovered
165	34.4	75	45.2	1.92 to 1	68.3
"	"	100	56.8	2.44 to 1	67.7
172	37.7	75	47.4	1.82 to 1	69.2
"	"	100	59.5	2.27 to 1	69.4

Depth of the Deposits

The greatest length of ore that may be considered to be a continuous lens is the main band that is folded to form Island 84. This is found as a series of lenses on Island 162. Eastward it bends back beneath the lake and can be traced by magnetic disturbances to a point between Island 17 and the long sand point on the south shore. This is a total length of nearly five miles. Owing to the plunge of the folds it may be assumed that the beds continue down the dip at least half the distance that they can be followed on the strike. This assumption is based on a supposed circular form for the original basin and the truncation of the tilted beds approximately along a diameter of the basin. If this be granted the depth to which the lens may be expected to continue at Island 84, assuming an average plunge of the fold of 45°, is something over two miles.

Possibility of Enriched Lenses

In the Lake Superior deposits the original iron minerals have been altered and the iron content increased by leaching by downward moving surface waters, and as a result, in certain structural basins, there occur great bodies of high-grade residual iron ores. Some have assumed that iron formation of the type found at Lake St. Joseph may have been enriched in similar fashion, and that synclines will be found to contain ore bodies. Further, the impression has become current that lake basins are structural hollows and so should be underlaid by deposits of iron. The differences between the iron ore bodies of Lake Superior and those of Lake St. Joseph are fundamental. The Lake Superior bodies were leached by surface waters either soon after deposition or at any rate while still near the surface. The Ontario deposits were not affected by an erosion period following the deposition of the sediments, but so far as can be seen the period of sedimentation graded directly into the period of igneous extrusions. That is, the iron beds were covered almost immediately after deposition, and there was no opportunity for surface alteration or lateritization. They were again exposed only after a very long period, and after the folding of the region had been accomplished. This disturbance compressed the whole series into synclines and anticlines, and metamorphosed the original iron minerals into dense magnetite and hematite, associated with the fine-grained quartz. There is little possibility of the leaching of material from this fine-grained aggregation along the exposed edges of the up-turned beds, and the iron-bearing beds show none of the porous structure which they should exhibit had they undergone any such alteration. So far as the possibility of deposits in lake basins is concerned, there is no evidence to support such an assumption. The magnetite beds mostly form ridges. Some parts of them are beneath the lake but this is probably due to causes other than the physical character of the iron formation.

Possibility of Concealed Lenses of Magnetite

In most places the magnetite occurrences are well exposed, but in that part of the area covered by terminal moraine, sand and gravel conceal even the ridge-forming rocks. Traverses with the dial compass and dip needle were made at closely spaced intervals in the section south of Lake St. Joseph. Little magnetic disturbance was found, and there is not much likelihood of hidden lenses of any importance.

Quartz Veins

Many stringers and veins of quartz occur in the granite, but none of these were sampled. Veins of any workable size in rocks earlier than the granite were sampled, and assays of two of these were made at the Provincial Assay Office, Toronto, with the following results:

	No. 31	No. 36
Gold	none	none
Silver	2.08 oz. per ton	none

Sample No. 31. Sample chipped across a series of quartz veins on the northwest side of Island 34. Total width of quartz is four feet in a zone twenty feet wide.

Sample No. 36. Sample chipped across a quartz vein seven chains inland from the lake south of Island 84. Width of vein—ten feet, length exposed—100 feet.

No large veins were seen in the greenstones. The rock association with granite intruding basic rocks should have been favourable for the formation of gold-bearing quartz veins. If such occur anywhere in the district the greenstone areas east and west of the granite embayment along the north side of Lake No. 2 should be an exceptionally favourable locality for prospecting.

EASTERN PART OF LAKE ST. JOSEPH

By E. L. Bruce

Introduction

The following preliminary report deals with an area lying east of that covered by the report on "The Iron Formation of Lake St. Joseph." Townships were blocked out south of the lake by J. S. Dobie, O. and D.L.S., during the season of 1921, and the whole south shore of the lake as far east as Osnaburgh Indian Reserve and a part of the north shore were surveyed by him. The second base line was run east from Mile 66 on the primary meridian, and meridians were run north every six miles, from the base line to the lake shore. Bays from the main lake cross the base line between Mile 10 and Mile 12 and just west of Mile 14. The large bay southwest from Osnaburgh House extends nearly to the base line at Mile 22.

Rock outcrops along the shores were examined with considerable care, and the surveyed lines were traversed. Exposures are too scattered to attempt to make a complete areal map, and only actual occurrences of rock seen are shown on the map accompanying this report. No traverses inland were made other than those on the surveyed lines, both because of lack of time and because the small areas of solid rock to be seen did not seem to justify closely spaced sections.

Summary

The general character of this section is very similar to that to the west. There seems to be less burned country than in the western area, and some sections of very good pulpwood are to be found. The geology of the district is comparable to that of the west, but as much of it lies in the terminal moraine area, less rock is exposed. Iron formation is found, but the beds are much thinner than those of the western district and are not of workable size.

Timber

The best area of pulpwood seen anywhere in the vicinity of Lake St. Joseph is along the meridian running north from Mile 18 to the lake. Good timber extends eastward along the base line for about a mile east of the meridian. Westward there is no burned country as far as the lake at Mile 14. Unburned areas were seen north of the lake, but no examination of any of that part of the country was made.

Geology

The rocks belong to the same geological groups as those described in the report dealing with the western part of Lake St. Joseph, but there is some modification in the various types. The relations are expressed by the following table:

TABLE OF FORMATIONS

Age	Relations	Rock Type
Recent		Peat
Glacial		Clay, sand, gravel
	Unconformity	
Pre-Cambrian	GRANITE AND OTHER INTRUSIVES	Pegmatite dikes, granite, hornblendite and diorite, lamprophyre dikes.
	Intrusive Contact	
	PRE-GRANITE COMPLEX	*Igneous Group*— Greenstone, chlorite schists. *Sedimentary Group*— Iron formation, biotite-garnet-gniess, staurolite schist, quartzite, arkose, conglomerate.

Pre-Granite Complex

General

The rocks older than the igneous intrusions associated with the granite batholiths are grouped into a lower sedimentary series and an upper igneous series, although in this area there is little conclusive evidence of the relative ages. The sedimentary group consists of garnet-biotite-quartz gneiss, quartzite, arkose, and magnetite beds. There are many occurrences of garnet and staurolite schist and one of conglomerate. The igneous group is not important areally. The rocks are massive greenstones, but are not ellipsoidal, and some of them may be highly altered greywackés.

Sedimentary Group

Conglomerate.—Outcrops of conglomerate are crossed by the base line east of the twentieth mile post. The first bed is two chains east of the post. It is 10 feet thick, and contains well rounded pebbles of granite, quartz and bluish chert in a granular siliceous matrix. Conglomerate is interbedded with rusty weathering mica gneiss 7 chains east of Mile 20. The beds vary in thickness from two inches to 2 feet. Granite lies directly west, but not in direct contact with the conglomerate. Pebbles of granite in the conglomerate might lead to the inference that there is an unconformity, but it is believed the granite is younger, as it is found intruding the gneissic rocks on the meridian north from Mile 18, along the base line at Mile 22 + 25 chains, and at various points along the shore of the lake north of that part of the base line.

Other Sedimentary Rocks.—Gneisses of sedimentary origin are the most commonly exposed rocks. Large areas of garnet gneiss extend from the base line between Mile 20 and Mile 22 + 25 chains northward to the lake. Light pink garnets make up a large proportion of the rock mass. Staurolite schist is interbanded with garnet gneiss in many places. The crystals of staurolite are an inch or more in diameter, and form the greater part of the rock. Both single crystals and twin crystals are found. They are not parallel to the bedding, and have evidently formed subsequent to the folding of the rocks. The matrix in which they lie is largely sericite. Quartzite was observed at some localities along the shores of the bay crossed by the base line between Mile 10 and Mile 12. Some of these are brecciated, with the fragments recemented by quartzite. Under the microscope they appear to be typical quartzites with rounded grains of quartz, some feldspar, and sericite as an alteration product, Fig. 1.

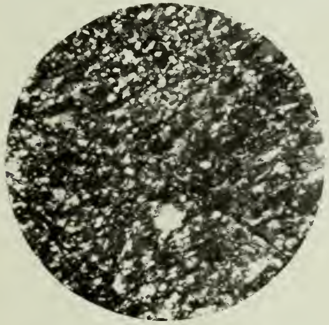


Fig. 1.—Photomicrograph × 30 of quartzite from the south side of the bay crossed by the base line between Mile 12 and Mile 14, eastern part of Lake St. Joseph.

Magnetite beds are interlayered with other sediments, but are much thinner and leaner than are the beds of the western part of the lake. Most of them are only a few inches in thickness, but zones occur several feet in width in which one-half of the rock consists of magnetite. The rocks commonly interbanded with magnetite are garnet gneiss, and staurolite schist. At the north side of Island 856, the rock immediately north of the iron formation is dark in colour and weathers to a nodular surface. In the field, it had the appearance of an igneous rock. Microscopic examination shows that the chief minerals are quartz, and fresh-looking green hornblende. The quartz individuals form a closely interlocking mosaic, and it seems probable that the rock is really an abnormal sediment in which the basic material has re-crystallized into hornblende. The magnetite beds are the result of the re-crystallization of some original iron mineral associated with quartz or with some other mineral which has changed to quartz. Some samples of magnetite contain a few deep red garnets in perfectly formed crystals as large as small peas.

The magnetite-bearing beds along the base line are cut off, and bent sharply from their normal strike by granite intrusions. Pegmatite dikes in places cut directly through the magnetite beds. On Island 856 granite is in direct contact with a bed of magnetite, inclusions of which are contained in the igneous rock. Nevertheless, the granite appears quite fresh and unaffected right up the contact. The sediments are evidently older than this particular granite, and the drag-folding indicates a syncline to the north. This view is corroborated by the position of the granite, which probably came in from below.

Igneous Group

Greenstone.—Greenstone occurs along the shore of the Indian Reserve south of Osnaburgh House and on the islands in that vicinity. No ellipsoidal structure was observed, and the differentiation between basic lavas and sedimentary rocks made up of material formed by the breaking down of basic rocks is somewhat difficult. Owing to the disturbances caused by the igneous intrusions, the structure and succession are not easily determined, but there is some evidence, although not entirely conclusive, that the greenstone lies above the sediments.

Photograph by courtesy of the Air Board of Canada.

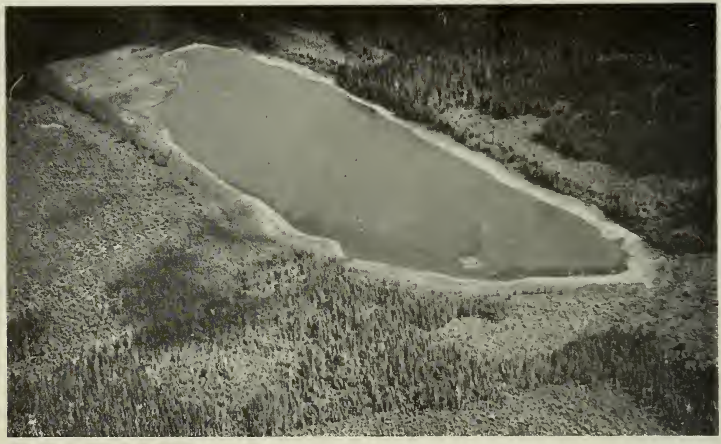


Fig. 2.—Lake in terminal moraine deposits, south of Lake St. Joseph. The photograph was taken on Sept. 15, 1921, from a height of 2,700 feet.

Granite and Other Intrusives

The intrusive rocks may belong to several different ages. Lamprophyre dikes cut the sediments, and holo-crystalline dioritic rocks are thought to be intrusive, although they have not been found in direct contact with other rocks. Granite and the pegmatite dikes associated with it are the most important intrusive rocks.

The lamprophyre dikes are similar in all respects to those described in the western section, and nothing need be added to that description. Such dikes were found cutting quartzite in outcrops in the marsh south of the bay which is crossed by the base line between Mile 10 and Mile 12. Diorite occurs on Island 648, on Island 709, and on several smaller islands near it. It is a completely crystallized rock of granitic texture, and may be related to the granite intrusion either as a differentiate from it or as a hybrid rock formed by the assimilation of basic material in the granite magma.

The granite is similar to that described in the previous report, but in this eastern section along many of the contacts there has been much more assimilation of the intruded rocks, and hence there are broad belts of hybrid rocks which differ from typical granite and vary in character from place to place. These have been included with the granite, although at many localities if each outcrop were considered by itself the rock could hardly be termed granite. This is especially true of the outcrops occurring on Carling island. Pegmatite dikes do not appear to be so numerous as they are in the western section, but this may be due to the fact that the amount of solid rock exposed is much less. The dikes are similar to those previously described.

Photograph by courtesy of the Air Board of Canada.

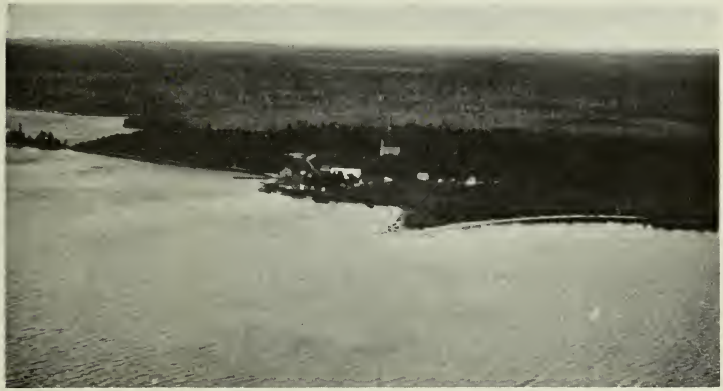


Fig. 3.—Osnaburgh House, Lake St. Joseph, viewed from an elevation of 800 feet. The H. B. Co. post is built on a hill of glacial sand with a sand pit in front of it.

Pleistocene Deposits

Deposits formed during the glacial period are thick and wide spread. Banks of sand and gravel cover all the solid rock over much of the area. Most of the deposit is typical terminal moraine, with hummocky and irregular hills, elongated knolls and winding esker-like ridges. Southeast of the lake and from Mile 22, eastward on the base line, the glacial deposits are thick and continuous, and as the forest has been almost completely burned away, the irregular hills and ridges of unsorted sand and gravel, among which lie lakes with no visible outlets, can be seen extending for a long distance to the south. Another great area of glacial deposits lies between the lake and the base line west of Mile 20. Forest cover obscures some of the details, but the oval lakes with no rock exposures can be recognized, Fig. 2.

Recent

At present, peat is forming in some of the undrained areas, and the glacial sands and gravels are being rearranged by the lake currents into new shore deposits. The abundant supply of sand has made possible some splendidly developed sand bars and sand spits, Fig. 3.

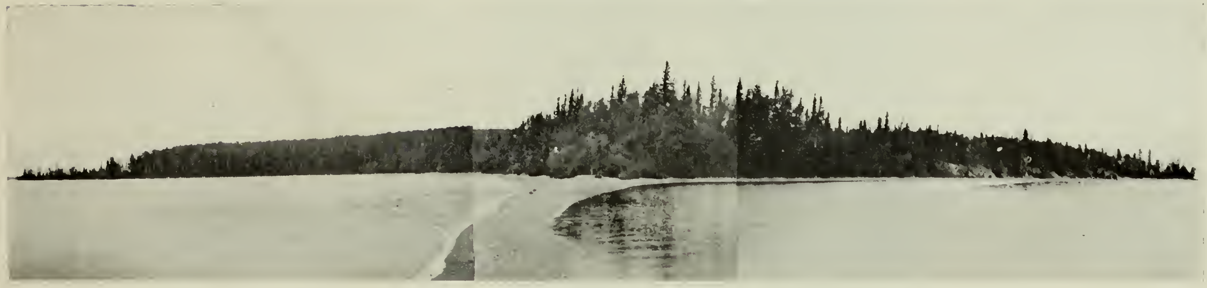


Fig. 4.—Island 670, Lake St. Joseph, showing sand spit formed on the south side.

AREA SOUTH OF THE WEST END OF LAKE ST. JOSEPH

By E. L. Bruce

Introduction

A lake of considerable size was reported to lie in the unmapped area south of Lake St. Joseph and west of the primary meridian. An exploration was decided upon to determine the location and size of the lake and, if possible, to obtain additional information with regard to the character and structure of the sedimentary gneisses that occur along the south shore of Lake St. Joseph. A sketch furnished by J. S. Dobie, was found to agree fairly closely with the position of the lake. The name Shekak is suggested for this body of water, as it is said that a man named Skunk formerly trapped in that section.

The lake is reached by ascending a fair-sized stream that enters the large bay extending southwestward from the main channel of Lake St. Joseph, three miles east of the primary meridian. A rapid occurs at the mouth of this stream but this can be easily ascended by poling. Half a mile above the rapid a tributary enters from the west. This drains two small lakes, the upper of which is crossed by the meridian at Mile 57. Half-a-mile west of the meridian a stream enters the lake with a heavy rapid at the mouth. This was ascended by tracking, but there is an old portage eleven chains in length on the right bank. The lower end of the portage is a little distance south of the mouth of the stream. Shikkagami lake is directly above the rapids.

The lower part of the lake extends westward for four miles to a large island which blocks the passage, leaving only a narrow channel on either side. From this island the lake extends in many long bays to the southwest. The most southerly bay reaches a point ten miles southwest of the narrows, and so the lake has a total length of about fourteen miles. The greatest width is three miles. The track survey by canoe was supplemented by a flight over the lake by seaplane; this made possible some corrections in outline and the recognition of connecting lakes, which drain into the southeast bay and may form a canoe route for some distance southward.

The waters of Shekak lake are fairly clear with a slightly brownish colour, but not the dark brown of the water in many lakes near the head of river systems in pre-Cambrian regions. This is due to the comparatively small proportion of swampy country in its drainage basin, for much of the district is covered by the sandy glacial deposits of the terminal moraine extending southwestward from Lake St. Joseph. The irregular ridges and knolls of glacial sand and gravel can be well seen on large islands in the central part of the lake, where the forest fires have removed the timber. Much of the mainland of this part is wooded, but the long, smooth, pebble beaches are typical of the drift-covered area. The southwestern end is beyond the margin of the moraine and lies in a rugged country with high, bald ridges and knolls of granite.

Geology

Outcrops are fairly numerous at the lower and upper ends of the lake, but the central part has boulder and sand beaches with few exposures of solid rock. The stream draining the lake, and a small part of the lower end of the lake, lie in an area of granite continuous with the granite area found along the base line south of Lake St. Joseph. The rock of the central part of Shekak lake is brown-weathering mica gneiss, with little variation except that produced by the metamorphic effect of granite intrusions. Toward the south, where the second great belt of granite appears, the gneisses are very severely altered. They are thoroughly impregnated with material from the intrusive and, in many places, it is difficult to draw any satisfactory line between the two rocks. The gneiss is undoubtedly of sedimentary origin. The distinctly bedded character and the highly quartzose composition are conclusive evidence of this. As in the gneisses of Lake St. Joseph, it is rather difficult to account for this thick series of sedimentary beds so homogeneous in nature, apparently clastic, but with no conglomeratic beds whatever.

The intrusion of the granite has taken place largely *lit-par-lit* and in many places the original bedded structure is retained, although the material of the rock is now more largely igneous than sedimentary. This type of intrusion adds considerably to the difficulty of satisfactory mapping, as granite and gneiss interfinger most intimately along the contact. The gneisses are also intruded by large pegmatites, many of which have come in along the bedding, and as they form ridges, an erroneous opinion of the relative importance of gneiss and pegmatite may be formed. In some cases what appear to be ridges of solid pegmatite are found on closer observation to be gneiss, faced with pegmatite.

The structure of the gneiss at the lower end of the lake is well shown. Where first observed the dip is steep to the northward and the strike nearly east and west. To the south, the strike swings to the northwestward and the dips flatten to 45° to the northeast. Still farther south the strike is north and south, and the dip 15° to the east. Continuing southward, the strike is northeast-southwest with dips to the southeast and then swings east and west again with steep dips to the south. It is evident that the structure is a closely appressed anticline which plunges to the east at an angle of 15°. The dips farther south give some evidence of a minor syncline, the axis of which is only a short distance south of this main anticlinal axis. There may be a second anticlinal axis towards the south end of the lake, but the disturbance introduced by granite intrusions makes the evidence less clear. The relation of this structure to that of the gneiss along Lake St. Joseph is not determinable. It is believed from evidence given in detail in a previous report that the Lake St. Joseph occurences are on the northern limb of an anticline. If it be assumed that the Shekak Lake anticline is the first anticline south of Lake St. Joseph, and that it occupies its original position, the thickness of sediments is enormous. It seems more reasonable to assume that there are some intermediate folds now completely destroyed by the granite intrusion. It is also possible that there has been a fault zone along which the granite has come in. In that case the anticlinal crest exposed on Shikkagami lake may be down-faulted part of beds originally lying much farther north. So far as the problem of the structure of the Lake St. Joseph beds is concerned, the evidence is at least corroborative of the eastward plunge of the axes of the folds.

No evidence of any mineralization of possible importance was observed in any of the exposures seen along the lake shores.

INDEX

Vol. XXXI., Part VIII.

PAGE

Agriculture.
  St. Joseph l. ... 6
Analyses, iron ores ... 30, 31
Andesite ... 2
Anticline ... 13, 40
Archean shield. *See* Pre-Cambrian.
Arkose.
  St. Joseph l. ... 7, 34
    description ... 9
    petrography ... 25
Assays.
  Quartz, L. St. Joseph ... 32

Batholiths ... 2
Bell, Dr. Robt. ... 2, 23
Biotite-garnet gneiss.
  L. St. Joseph ... 7, 34
Biotite gneiss ... 7
Blackstone l.
  Boulders ... 21
    photo ... 20
  Rocks ... 4, 17
Boulders, glacial.
  Blackstone l., notes and photo ... 20, 21
Bruce, E.L.
  Reports by, on St. Joseph l. ... 1-40

Camsell, Charles ... 2
Canadian shield. *See* Pre-Cambrian.
Carling island ... 37
Carter, Capt. A. W. ... 1
Chemical precipitation.
  As origin of iron deposits ... 27
Chlorite schist, St. Joseph l. ... 7, 23, 34
  description ... 16
Clastic sedimentation.
  As origin of magnetite deposits ... 26
Clinton iron ores ... 27, 28
Comer, J. F. ... 1
Concentration of iron ore.
  St. Joseph l., ratio ... 31
Conglomerate.
  St. Joseph l. ... 34
    magnetite nodules in, photo ... 10
Contact metamorphism.
  As origin of magnetite deposits ... 26
Couchiching series ... 13

Davison, John E. ... 2
Diamond-drilling.
  Iron, St. Joseph l. ... 24
Diorite.
  St. Joseph l. ... 7, 16, 17, 36
Dobie, James E. ... 1, 2, 33, 39

Farming. *See* Agriculture.
Fawcett, Thomas ... 2
Fish.
  St. Joseph l. ... 3, 6
Forests. *See* Trees.
Formations. *See* Table of formations.
Fraser, G. L. ... 1

PAGE

Fur-bearing animals.
  St. Joseph l. ... 3

Garnets.
  St. Joseph l., in magnetite ... 25, 27
Geology, economic
  See Granite; Iron; Gold.
Geology, general
  St. Joseph l. ... 7-22
    eastern ... 33-37
    western ... 39, 40
Glaciation.
  St. Joseph l., notes ... 21, 37
Gneiss.
  L. St. Joseph ... 4, 7, 8
    structure ... 40
Gold.
  St. Joseph l., possibility ... 3
Graham, S. N. ... 31
Granite.
  See also. Binary granite.
  L. St. Joseph ... 2, 4, 7
    notes ... 19, 20, 26, 36
Granite porphyry.
  St. Joseph l. ... 7, 19
Gravels, glacial
  St. Joseph l., photo ... 4
Greenalite.
  L. Superior iron deposits ... 27
Greenstone.
  L. St. Joseph ... 7, 34
    description ... 36
    intruded by granite ... 20
    prospecting advisable ... 32
Greig, J. W. ... 1, 16
Greywacké.
  L. St. Joseph ... 4, 7
    description ... 9
    petrography ... 25
  Savant l. ... 29

Hematite. *See also.* Iron-bearing beds.
  L. Superior iron ores ... 28
  St. Joseph l. ... 3
Hints to prospectors.
  Quartz veins, St. Joseph l. ... 32
Hornblende schist.
  St. Joseph l. ... 23

Iron formation.
  L. St. Joseph, Report by Bruce ... 1-32
    eastern ... 33-36
    mineralogy ... 24, 25
  L. Superior, origin ... 27
  Savant l. ... 13, 29
Iron-bearing beds.
  See also Iron formation.
  L. St. Joseph, geology ... 10-13
Island No. 6 ... 19
Island No. 10 ... 19
Island No. 17 ... 31
Island No. 34 ... 32

PAGE

- Island No. 84.
  - Folding, photo 13
  - Magnetite 4, 23, 30, 31
  - Photo 24
  - Quartz, assay 32
  - Rocks 9, 25
- Islands Nos. 103 and 104 15
- Islands Nos. 119 and 123 15, 17
- Island No. 131.
  - Magnetite, analysis 30
- Island No. 133 25
- Island No. 158 25
- Island No. 162.
  - Magnetite 30, 31
- Island No. 184.
  - Folding, photo 13
- Island No. 185 9
- Islands Nos. 212 and 250 15
- Island No. 276 17
- Island No. 337 8
- Island No. 353 8
- Island No. 400 14, 16
- Island No. 407 9
- Island No. 648 36
- Island No. 670
  - Sand spit, photo 38
- Island No. 709 36
- Island No. 856 35

- Jackpine.
  - St Joseph l. 6
- Jasper.
  - Iron formation 27
  - Savant l. 29

- Lake No. 1.
  - Glacial drift near, photo 4
- Lake No. 2, granite 19
  - Prospecting advisable 32
- Lake Superior
  - Iron ore, alteration 31
    - origin 27, 28
- Lamprophyre dikes 2, 16, 17, 22
- Laurentian shield. *See* Pre-Cambrian.
- Lava.
  - St. Joseph l., notes 16, 17, 22
- Lawson, A. C. 13

- McInnes, William 2
- Magnetic variation
  - St. Joseph l 23, 31
- Magnetite.
  - *See also* Iron-bearing beds.
  - St. Joseph l., notes and photo 3, 10, 30
    - Island No. 84 4
- Manitou rapids 2
- Mica gneiss, L. St. Joseph 34
  - Shekak l. 40
- Mile No. 10 35
- Mile No. 12 35
- Mile No. 14 35
- Mile No. 18 34
- Mile No. 20 34, 35
- Mile No. 22 34
- Mineralogy, iron formation 24, 25
- Moore, E. S. 29
- Moraines, terminal
  - L. St. Joseph 2
    - photos 5, 38

PAGE

- Murray, G. B. 1

- Osnaburgh House.
  - Agriculture 6
  - Rocks near; photo 36, 37

- Paragneiss 7, 8
- Parsons, A. L. 2
- Patrician glacier 5
- Peat bogs 21, 37
- Pegmatite.
  - L. St. Joseph 2, 4, 34
    - age 22
    - description 20
    - intruding gneisses 40
- Petrographic notes.
  - Gneiss, L. St. Joseph 8
  - Iron formation 25
- Photomicrographs.
  - Quartz porphyry 14, 18
  - Quartzite 35
- *Picea* 19
- Pickerel
  - L. St. Joseph 6
- Pike, L. St. Joseph 6
- Pleistocene 21, 37
  - *See also,* Glaciation.
- Poplar 6
- Porphyry. *See* Granite porphyry.
- Pre-Cambrian.
  - L. St. Joseph area 2, 34
- Pre-granite complex.
  - L. St. Joseph area 7-19, 34, 35
- Prospecting.
  - *See also* Hints to prospectors.
  - L. St. Joseph, historical notes 23
- Pulpwood 6, 33
- Pyroclastics 7, 16, 17
  - photo 18

- Quartz-hornblende gneiss 7, 9
- Quartz porphyry.
  - St. Joseph l. 2, 7, 10
    - age 19
    - photomicrograph 13-18
- Quartz veins.
  - L. St. Joseph, non-auriferous 3, 32
- Quartzite.
  - L. St. Joseph 7, 9, 34
    - cut by dikes 36
    - description 10
    - photomicrograph 35
    - structure 4

- Recent deposits.
  - L. St. Joseph area 21, 37
- Rhyolite 16
- Rock structure.
  - St. Joseph l., relation to topography 4
- Root river 2, 6

- St. Joseph lake.
  - Reports on, by Bruce 1-40
- Sand, glacial
  - St. Joseph l., notes and photos 3, 4, 37
- Sand bars or spits.
  - St. Joseph l., notes and photos 5, 21, 37, 38

PAGE

Sand pit.
  Osnaburgh House, photo........... 37
Savant lake.
  Iron ore, description............13, 29
  Rocks 16
Sea water.
  Hematite in, as origin of iron ores 28
Sedimentary group.
  L. St. Joseph area..........7-19, 34, 35
Sedimentation.
  See also Clastic sedimentation.
Sericite schist 7, 10
Shekak lake 6, 13, 39, 40
Silver.
  St. Joseph l., in quartz............ 32
Sioux Lookout...................... 2
Skunk l. *See* Shekak l.
Soil. *See* Agriculture.
Spits. *See* Sand bars.
Spruce 6
Station No. 13..................... 9
Station No. 136.................... 9
Station No. 146.................... 9

PAGE

Station No. 207..................... 8
Staurolite schist.................34, 35
Striæ, glacial
  L. St. Joseph..................... 21
Syncline
  L. St. Joseph, iron ore possible in. 31

Table of formations. L. St. Joseph 7, 34
Topography
  L. St. Joseph area................3-6
Trees
  L. St. Joseph, area..............6, 33

Volcanic group
  St. Joseph l., area...............7-19

Waterpower
  L. St. Joseph..................... 3
Whitefish 6
Williams, Jabez.................... 24
Williams, L. F..................... 1
Williams, L. G..................... 1
Wilson, A. W. G.................... 2
Wright, David...................... 1

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES — THOS. W. GIBSON, DEPUTY MINISTER

THIRTY-FIRST ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXI, PART IX, 1922

The Stratigraphy and Paleontology

OF

Toronto and Vicinity

PART III.—GASTROPODA, CEPHALOPODA, and VERMES

By

W. A. Parks, Ph.D. assisted by Madeleine Fritz, B.A.

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed by CLARKSON W. JAMES, Printer to the King's Most Excellent Majesty
1923

Printed by
THE RYERSON PRESS

THE STRATIGRAPHY AND PALEONTOLOGY OF TORONTO AND VICINITY

Part III.—Gastropoda, Cephalopoda, and Vermes

By

W. A. Parks, assisted by Madeleine Fritz

Introductory

Two parts of this series have already appeared in the Reports of the Ontario Department of Mines: they deal with the Pelecypoda [1] and Molluscoidea [2] occurring in the rocks at Toronto.

The present part treats similarly of the classes Gastropoda, Cephalopoda, and Vermes.

The series of articles of which this is the third number was undertaken in order to furnish a full and modern account of the fossils occurring in the rocks at Toronto. As the original illustrations of most of the species are contained in literature difficult of access, it has been decided to introduce a figure of each species referred to.

In the two parts already published, as also, in the present part the fossils are described without particular reference to their range as it is the intention to fully consider this aspect of the subject in Part IV, to be published at a later date. It will deal with the remaining groups of fossils and with the stratigraphy and correlation of the local formations at Toronto.

The *Gastropoda* of the Toronto rocks are very badly preserved; in consequence, great difficulty attends some of the identifications. We recognize ten described species to which we have added one new variety and one doubtful species, too uncertain to be definitely named.

The *Cephalopoda* show five species; of these *Actinoceras crebriseptum* is so abundant and so unique that considerable space has been devoted to a description of the detail of its structure.

The *Vermes* are represented by one tubicolar annelid and thirty-four errant types of which only the jaws are known. We have been able to add nothing to Hinde's excellent account of these minute structures: his descriptions and figures are reproduced without change. It has been thought advisable to include the five *conodonts* (teeth of *cyclostomes* ?) described by Hinde.

A single species of *Conularia* is included.

The figures accompanying Part III have been prepared partly by ourselves and partly by Miss Emily Logier. In a few cases it has been found necessary to reproduce figures already published.

---

[1] Ont. Dept. Mines Report, Vol. XXIX, Part VI, 1920.

[2] Ibid, Vol. XXX, Part VII, 1921.

Description of Species

The species herein described belong to the two great phyla: *Mollusca* and *Vermes*. Of the former, the two classes considered are the *Gastropoda* and the *Cephalopoda*. Without further introduction these two classes will be first dealt with.

GASTROPODA

Order ASPIDOBRANCHIA

Family ACMEIDAE

Genus ARCHINACELLA, *Ulrich and Scofield*

ARCHINACELLA, *Ulrich and Scofield.* Geol. Minnesota 3, pt. 2, 1897, pp. 821-828.
ARCHINACELLA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 61.

The small shells now placed under this genus have been variously ascribed to *Metoptoma, Triblidium,* and other genera. *Archinacella* is defined as follows by Ulrich and Scofield:

> Shell patelliform, ovate to subcircular, usually widest anteriorly, forming a low cone with the apex in front of the center and often submarginal. Muscular scars forming a continuous band. Surface markings concentric only.

ARCHINACELLA PULASKIENSIS, *Foerste*

Plate 1, Figures 1 and 2.

CARINAROPSIS PATELLIFORMIS, *Hall.* Pal. New York, 1, 1857, p. 306, pl. 83, figs. 7a-b.
ARCHINACELLA PULASKIENSIS, *Foerste.* Bull. Sci. Lab. Denison Univ., 17, 1914, p. 309. pl. 3, figs. 3a-d.
ARCHINACELLA PULASKIENSIS, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p.64.

The true *Archinacella patelliformis* of Hall is defined as follows:

> Obliquely subconical, patelliform, the apex incurved and extended in a line with or beyond the margin, obtusely carinated upon the dorsal line; aperture broadly oval, slightly narrowed posteriorly; surface marked by fine concentric sublamelliform striae.
>
> This species resembles in form the recent *Capulus;* but the structure of the shell is quite different, being, in this respect, closely allied to the *Bellerophon.* There are one or two other species in the Hudson River group, and a single more elevated one in the Trenton limestone, which has not been satisfactorily determined.

Hall himself ascribed to the same species certain specimens from the Hudson River group at Pulaski and elsewhere. Foerste (*op. cit.*) has pointed out that the Trenton and the Hudson River types of Hall are different and has proposed the name *A. pulaskiensis* for the latter. His comments on the two species are as follows:

> The form figured by Hall from the Lorraine at Pulaski, New York, as *Archinacella patelliformis*, differs in outline from his Trenton types, which were derived from the dark, compact, Trenton limestone at Middleville, New York. This shell is broader and more convex along the middle and the outline, therefore, is rather broadly ovate than ovate oblong. Otherwise the two shells are closely similar. The beak extends almost or fully as far forward as the anterior margin of the shell. It overhangs this margin by an anterior slope which on lateral view is not so strongly concave. The beak is rather pointed, especially when viewed from above, and there is a tendency toward carination for a moderate distance posterior to the beak. The highest part of the shell is about five-twelfths of the length of the shell from the anterior margin. The shell is smooth, surface striations being faint or absent.
>
> The type of the species occurs in the same rock with *Modiolopsis modiolaris, Byssonychia radiata, Hormotoma gracilis, Dalmanella.* and *Glyptocrinus* columnals.
>
> This species occurs at the *Trinucleus* horizon, several hundred yards west of the railroad bridge across the river, east of Pulaski. It is found also northeast of the bridge within the limits of Lorraine village, and along the creek within the boundaries of Barnes Corners. It is found also at the power house at Bennett Bridge, a little over a mile west of the Salmon River falls.

The same species occurs in the province of Quebec, on the Richelieu river at Chambly. A similar form is found on the Nicolet river, southwest of Ste. Monique, about 575 feet below the lowest horizon containing *Strophomena planumbona.*

This type of gastropod is quite common at Toronto and approaches more closely *A. pulaskiensis.* The specimen drawn is a cast of the interior, but it shows well the ovate outline characteristic of the species and also the continuous muscle band which Ulrich considers characteristic of the genus. The length is 16 mm. and the width is 13.5 mm. Considerable variation in size is observed, some specimens being as much as 26 mm. long. Variations are also observed in the degree to which the ridge posterior to the apex is developed, some specimens being quite rounded.

Locality.—Don brickyard, Toronto.
No. 1211 H.R. Royal Ontario Museum of Paleontology.

Family CYRTOLITIDAE

Genus CYRTOLITES, *Conrad*

CYRTOLITES, *Conrad.* Ann. Rep. Nat. Hist. Surv. New York, 1838, p. 118.
CYRTOLITES, *Ulrich and Scofield.* Geol. Minnesota, 3, pt. 2, 1897, pp. 846-858.
CYRTOLITES, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, pp. 365, 366. (See for full bibliography).

Ulrich and Scofield describe the genus as follows:

Shell coiled in the same plane, symmetrically or nearly so; volutions two or three, scarcely contiguous, the last occasionally free, enlarging gradually, carinated on the back and often on the sides, giving a subquadrate cross-section; aperture not abruptly expanding, with or without a median notch in the outer lip; no slit-band; shell thin, without callosities of any kind; surface sculpture reticulated or cancellated, consisting of straight or obliquely curved regular transverse lines connected by short oblique lines.

CYRTOLITES ORNATUS, *Conrad*

Plate 1, Figures 3, 4 and 5.

CYRTOLITES ORNATUS, *Hall.* Pal. New York, 1, 1847, p. 308, pl. 84, figs. 1a-g.
CYRTOLITES ORNATUS, *Chapman.* Canadian Jour., new ser., 7, 1862, p. 119, fig. 119; 8, 1863, p. 206, fig. 207.
CYRTOLITES ORNATUS, *Billings.* Geol. Canada, Geol. Surv. Canada, 1863, p. 217, fig. 226.
CYRTOLITES ORNATUS, *Meek.* Pal. Ohio, 1, 1873, p. 148, pl. 13, figs. 3a-b.
CYRTOLITES ORNATUS, *Ulrich and Scofield.* Geol. Minnesota, 3, pt. 2, 1897, p. 860, pl. 62, figs. 27-29.
CYRTOLITES ORNATUS, *Cumings.* 32nd Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 962, pl. 40, figs. 8, 8a.
CYRTOLITES ORNATUS, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 367.
CYRTOLITES ORNATUS, *Foerste.* Geol. Surv. Canada, Mem. 83, 1916, pp. 85, 90.

Cyrtolites ornatus is one of the most common gastropods found in the Toronto vicinity. Although the species occurs in abundance, well-preserved examples are rare, as most specimens are much flattened and distorted.

A description by Ulrich and Scofield follows:

Shell varying in diameter between 12 mm. and 30 mm., with the average at about 23 mm. Volutions two or three, rapidly increasing in size, strongly and sharply carinate dorsally, rhombic subquadrate in section; sides prominent and subangular or narrowly rounded along a line about three-fifths of the hight of the volution within the dorsal carina, the dorsal slopes gently convex and distinctly undulated by strong slightly curved transverse furrows and subangular ridges, the ventral or umbilical slopes almost flat and usually without undulations; ventral side with a sharp central furrow for the reception of the dorsal carina of the preceding volution. Umbilicus well defined, wide and deep, the edge wavy. Aperture a little wider than high, the hight equalling usually a trifle more than half the greatest diameter of the shell, more or less rhombic-subquadrate, the outline often becoming a little rounded with age. Entire surface covered by a delicate network formed of raised lines running almost straight across the whorls and short connecting lines arranged alternately, the result being somewhat similar to the pitting of a thimble. In a good light the network is generally distinguishable without the aid of a magnifier, and, excepting three specimens, quite uniform in strength in different shells, there being on the outer half of the last whorl nearly always seven or eight of the transverse lines and eight or nine of the short lines in 2 mm. In the excepted specimens the network is more compact, there being over the outer part of the last whorl from ten to twelve of the transverse lines in the same space. On another, with the reticulation unusually coarse, the number averages between six or seven. On the last specimen a good magnifier brings out some very fine lines of growth running through the network. It is important to note that there is no perceptible backward curvature of the transverse lines in nearing and crossing the dorsal carina.

The Toronto specimens seem to conform very closely with the figures and descriptions of this species already published. Owing to imperfections, the characteristic features of the apertural region cannot be verified. A degree of variation is observed in our specimens, but it is frequently impossible to determine whether these are inherent or due to crushing. For instance, the lateral angulation is in some cases much sharper than is indicated in published figures of the species, but it is quite possible that this is the result of pressure. The keel on the periphery, in some cases, is quite well defined, but in our best specimens it is merely a sharp angularity with but a slight concavity on either side. In these cases the finer surface ornamentation is quite uninterrupted across the keel. The chief direction in which variation occurs is in the number and strength of the transverse furrows and ridges; in some cases these are so sharply defined and prominent as to catch the eye at once, in other cases they are quite low and might almost be overlooked by the naked eye. In many specimens the ridges near the aperture are as much as 5 mm. apart, but in extreme cases the interval does not exceed 2 mm. The finer transverse ridges are likewise variable in distance, from two to four appearing in an interval of 1 mm. at approximately the same location on the shell of different individuals.

Our collection does not afford a specimen of sufficient perfection to furnish a better illustration than many of the published figures. The figures have been copied from Ulrich and Scofield with some slight changes. Figures 3 and 4 are from our specimen.

Locality.—6-foot level, Humbervale Quarry, Don brickyard.
Nos. 1208, 1209 H.R., Royal Ontario Museum of Paleontology.

Family SINUITIDAE

Genus SINUITES, *Koken*

SINUITES, *Koken.* Die Leitfossilien, Leipzig, 1896, p. 392.
PROTOWARTHIA, *Ulrich and Scofield.* Minnesota Geol. 3, 1897, pp. 848, 867.
BELLEROPHON, *Montfort.* Conchiliologie Systematique, 1, 1801, p. 51.
BELLEROPHON (part), *Auctores.*

The genus *Bellerophon* in the usage of many authors includes diverse types of thin-shelled, convolute gastropods with a central emargination of the outer lip, a well developed slit band, and with the volutions more or less rounded on the back. The genus *Protowarthia* was proposed by Ulrich for shells of this general type characterized as follows:

> Aperture large but not abruptly expanded, the outer lip bilobate, with a broad and more or less deep sinus but neither a slit nor band; dorsum convex, never carinate; umbilicus closed; surface markings very fine, generally consisting of more or less obscure crowded lines of growth and delicate revolving striae. The inner lip forms a thin granulose deposit over the dorsum of the inner end of the last whorl and extends on each side around the umbilical region. This portion is covered with interrupted or inosculating lines.

Ulrich's description appeared in 1897, but Koken had proposed *Sinuites* for shells of the same type a year earlier; thus the genus *Sinuites* has priority.

SINUITES CANCELLATUS, (*Hall*)

Plate 1, Figures 6, 7, 8.

BELLEROPHON BILOBATUS (*not Sowerby*), *Auctores*.
BELLEROPHON CANCELLATUS, *Hall*. Pal. New York, 1, 1847, p. 307, pl. 83, figs. 10a-c.
PROTOWARTHIA CANCELLATA, *Ulrich and Scofield*. Geol. Minnesota, 3, pt. 2, 1897, p. 872, pl. 63, figs. 1-14.
SINUITES CANCELLATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1159 (See for extended synonymy).

Examples of this species are fairly abundant in the Toronto rocks, but they are all very imperfectly preserved.

Hall's original description of the species follows:

> Involute, subglobose; aperture expanded, bilobate; dorsal line subcarinated; surface cancellated by fine concentric and longitudinal striae; concentric striae arching on the side, and meeting at a sharp angle upon the dorsal line; aperture with a sinus in the dorsal margin.

Although this species is abundant, we have found no specimen with shell preserved nor any which are not seriously deformed. In consequence, the figures given herewith have been copied from Ulrich and Scofield (*op. cit.*).

Family PLEUROTOMARIIDAE

Genus CLATHROSPIRA, *Ulrich and Scofield*

PLEUROTOMARIA (part), *Auctores*.
CLATHROSPIRA, *Ulrich and Scofield*. Geol. Minnesota, 3, pt. 2, 1897, pp. 954-1005.
CLATHROSPIRA, *Cumings*. 32nd. Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 948.
CLATHROSPIRA, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 228 (See for full bibliography).

The genus *Clathrospira* was established by Ulrich and Scofield (*op. cit.*) for the reception of those forms otherwise like *Eotomaria* but with the band nearly vertical and situated upon the periphery of the whorls, and with the surface beautifully cancellated.

The description of *Eotomaria* follows:

> Shell depressed-conical, sometimes sublenticular; base more or less convex, its bulk usually nearly equal to the apical part; umbilicus very small or wanting; volutions not very numerous, sometimes slightly turriculate or strongly angular near the mid-hight; aperture oblique; subquadrate, the inner lip slightly reflected or merely thickened, the outer deeply notched at the peripheral angle; no slit; band of moderate width, concave, sharply defined, oblique or horizontal, lying upon the apical side of the periphery. The surface markings consist of fine lines of growth only. These curve backward more or less strongly toward the band on both the upper and lower sides of the whorls.

CLATHROSPIRA SUBCONICA (*Hall*)

Plate 1, Figure 9.

PLEUROTOMARIA SUBCONICA, *Hall*. Pal. New York, 1, 1847, p. 174, pl. 37, figs. 8a-e; p. 304, pl. 83, figs. 3a-e.
PLEUROTOMARIA SUBCONICA, *Billings*. Geol. Surv. Canada, 1863, p. 180, fig. 174.
CLATHROSPIRA SUBCONICA, *Ulrich and Scofield*. Geol. Minnesota, 3, pt. 2, 1897, p. 1006, pl. 69, figs. 47-50; pl. 70, figs. 5-6.
CLATHROSPIRA SUBCONICA, *Cumings*. 32nd. Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 956, pl. 41, figs. 8, 8b.
CLATHROSPIRA SUBCONICA, *Foerste*. Geol. Surv. Canada, Memoir 83, 1916, p. 249. (See Bull. 92, U.S.N.M. for full synonymy).

The description of this species as given by Ulrich and Scofield follows:

Shell with a short conical spire, consisting, when fully grown, of six and a half or seven volutions, of which the two at the apex are usually broken away; greatest width and height nearly equal, varying generally between 25 and 30 mm., but attaining occasionally a width of over 40 mm.; apical angle 70° to 80°, but in four specimens out of every five the variation is only about one degree either way from 74°. Volutions flattened above in the direction of the slope of the spire, the inner half of the slope gently convex, the outer half correspondingly, or more strongly concave; convex portion of slope just touching or failing to reach a line drawn from periphery to periphery of succeeding whorls; under side of whorls rounded, occasionally very slightly concave near the periphery, this condition appearing, however, only in specimens in which the band is unusually prominent, umbilical depression small, terminating generally in a minute axial perforation. Band prominent, sharply defined, rather wide, concave, nearly vertical, situated on the periphery of the last volution, and lying immediately above the suture line on the upper whorls. Aperture subquadrate, outer lip broadly notched; columellar lip not very strong, thin, folding about the small umbilical perforation. Surface sculpture beautifully cancellated, consisting of two sets of fine, subequeal, thread-like lines, one revolving, the other running parallel with the margin of the aperture. The transverse lines, of which three to five occur in the space of 1 mm., are recurved as usual on the upper side and quite as much on the lower side. At intervals, sometimes quite regular, many specimens exhibit more or less distinct undulations of growth, in some examples little more than a millimeter apart, in others two, three, or four millimeters. Considerable variety as regards strength and arrangement of the lines forming the surface sculpture may be observed in specimens from different localities.

The occurrence of this species in our rocks is open to some question. In our collections we have only three or four small specimens, very imperfect, but which seem to show the general form of this species. In addition, we have a portion of an impression or external mould of a much larger example which conforms very closely to *Clathrospira subconica.* The specimen figured herewith was obtained from the vicinity of Toronto, but the character of the rock indicates, with reasonable certainty, that it has been derived from Trenton drift. The fine revolving lines, mentioned in the description, are scarcely discernible, but the transverse lines are very sharply defined. The umbilical portion has been copied from Ulrich and Scofield.

Locality.—Trenton drift, Toronto.
No. 292 T., Royal Ontario Museum of Paleontology.

Genus HORMOTOMA, *Salter*

MURCHISONIA (part), *Auctores.*
HORMOTOMA (subgenus of Murchisonia), *Salter.* Geol. Surv. Canada, Can. Org. Remains, dec. 1, 1859, pp. 18, 22.
HORMOTOMA, *Ulrich and Scofield.* Geol. Minn., 3, pt. 2, 1897, pp. 959, 1012.
HORMOTOMA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 643. (See for full bibliography).

Ulrich and Scofield describe the genus as follows:

Shell elongate, beaded, practically imperforate, composed of rather numerous (eight to fourteen) rounded or subangular whorls; aperture acuminate subovate, narrow and more or less prolonged below; outer lip with a broad and deep v-shaped notch and no slit; band median or submedian, generally obscure, of moderate width, flat or slightly concave, in the perfect condition margined on each side by a delicate raised line; surface marked with lines of growth only; these are never very sharp and always sweep backward very strongly, from below especially, to the band.

HORMOTOMA GRACILIS (*Hall*)

Plate 1, Figure 10.

MURCHISONIA GRACILIS, *Hall.* Pal. New York, 1, 1847, p. 181, pl. 39, figs. 4a-c.
HORMOTOMA GRACILIS, *Ulrich and Scofield.* Geol. Minn., 3, pt. 2, 1897, p. 1015, pl. 70, figs. 18-21, ? 22.
HORMOTOMA GRACILIS, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 645. (See for full bibliography).

The description by Ulrich and Scofield follows:

Hight 20 to 33 mm., apical angle very constantly about 18°. Shell small, slender; volutions about fourteen in a length of 30 mm.; rounded, generally with a slight angulation, on which lies the band, a little beneath the middle; band seldom preserved, when perfect, rather narrow, smooth, flat or faintly concave and margined on each side by a delicate raised line; suture simple, deep; lines of growth fine, bending strongly backward from the suture to the band, and beneath this curving very strongly forward again, the whole indicating a deeply notched mouth; aperture a little higher than wide, rounded except below where it is somewhat produced; inner lip reflected, forming a slightly twisted and thickened columella.

This species has been recorded from the rocks at Toronto by Nicholson and others; it is said to be abundant "in the Hudson River group, Lake shore, Toronto." The old collections of the museum and all the material hitherto obtained for the preparation of this report contain only two small internal casts which can reasonably be ascribed to this species: these were collected from the quarry on the Don by J. Townsend. These specimens are each about 12 mm. long showing four whorls only; both the apex and the umbilical portions are broken and lacking. Apical angle about 18°.

The species is subject to much variation and ranges from the Trenton to the Richmond. The type was described from the Trenton and varieties from as high as the Richmond. Our form approaches more closely to the type than to any of the described varieties but differs somewhat in having greater inclination of the sutures. The total number of whorls and the maximum size cannot be ascertained as we have no specimen sufficiently perfect.

The figure given herewith is prepared from these specimens with additions from published figures.

Locality.—Don brickyard, Toronto.
No. 1213 H.R., Royal Ontario Museum.

Genus LIOSPIRA, *Ulrich and Scofield*

PLEUROTOMARIA and RAPHISTOMA (part), *Auctores.*
LIOSPIRA, *Ulrich and Scofield.* Geol. Minnesota, 3, pt. 2, 1897, p. 953.
LIOSPIRA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 745. (See for full bibliography).

Ulrich and Scofield describe the genus as follows:

Shell sublenticular, the spire low, depressed conical, almost smooth, the sutures very close, scarcely distinguishable; volutions subrhomboidal in section, flat, gently convex or slightly concave above, sharply rounded at the periphery, convex below, and not infrequently angular at the edge of the umbilicus. The latter is usually present but may be filled entirely by an extension from the inner lip, in other cases it may be open during the younger stages only. Aperture deeply notched; band scarcely distinguishable as such, wide, situated on the narrow outer edge of the whorls though chiefly upon the upper side. Surface markings very delicate, rarely preserved, consisting generally of exceedingly fine transverse lines bending strongly backward on the apical side to the peripheral band over which they continue with little interruption to sweep sharply forward again on the lower side. Faint revolving lines occasionally observed.

LIOSPIRA HELENA (*Billings*)

Plate 1, Figures 11 and 12.

PLEUROTOMARIA HELENA, *Billings.* Can. Nat. Geol., 5, 1860, p. 165, fig. 8; Cat. Sil. Foss. Anticosti, Geol, Surv. Canada, 1866, p. 17.
LIOSPIRA HELENA, *Ulrich and Scofield.* Geol. Minnesota, 3, pt. 2, 1897, p. 994.
LIOSPIRA HELENA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 746.
LIOSPIRA HELENA, *Foerste,* Geol. Surv. Canada, Memoir 83, 1916, pp. 100, 104, 121, 123, 126.

The occurrence at Toronto of a low-spired gastropod of the general type of *Liospira helena, L. vitruvia, L. progue* is undoubted, but the exact specific reference of our form is very questionable. Our whole collection does not contain more than half a dozen examples all of which are compressed, devoid of surface ornamentation, and are destitute of any detail of structure in the basal region. Under these circumstances it seems ill-advised to attempt a specific identification. The best of our specimens show evidence of a concavity on the upper surface of the whorls and thus seem to approach most nearly to *L. helena*. Others might with equal probability be ascribed to *L. vitruvia* or *L. progne*.

Billing's original description of *L. helena* is as follows:

> Sub-lenticular, with an elevated narrowly rounded margin; spire depressed conical; whorls about four, the last one rather strongly concave on the upper side, the others only slightly so. On the under side of the shell the whorls are moderately convex, and the umbilicus closed. The aperture is a little wider than high, the upper part of the inner lip slightly indented by the body whorl, the lower half somewhat vertical, but rounded, the lower part of the outer lip from the umbilicus to the margin of the whorl gently convex, the portion above the margin, concave. In most specimens the suture is enamelled, the shell appearing to be continuous from the apex to the margin, but in some, especially those which are a little worn, it can be more or less distinctly seen; the last whorl usually drops a little below the margin of the next preceding, but even in such instances the suture is not very distinct. In the specimens from shaly rocks no surface markings are visible, but in those from the sandstone of Anticosti, the striae are distinctly visible curving backwards from the suture to the margin. They are very fine in general, but there are occasionally a few coarse ones at distances of half a line or thereabouts from each other. Width from ten to fifteen lines; height a little variable; usually about three fourths of the width.

The best of our specimens shows three whorls, but the total number is uncertain as the apex is broken. The upper surface of the whorls is distinctly concave, but the convexity below the suture, shown by Billings for *L. helena*, is much less pronounced. The suture, therefore, is more sharply defined, and the upper whorls seem to overhang the suture slightly, suggesting *L. abrupta* of Ulrich.

The margin of the body whorl is much thinner and sharper than in Billings' figure, but how far this may be due to compression it is impossible to say. The character of the aperture and umbilicus is not revealed by any of our specimens. The form figured is 22 mm. wide, and about 10 mm. high, measured from the umbilicus to the apex. The apical angle is 120°.

Locality.—Etobicoke river, one mile above Grand Trunk railway bridge.
No. 1202 H.R., Royal Ontario Museum of Paleontology.

Genus LOPHOSPIRA, *Whitfield*

MURCHISONIA AND PLEUROTOMARIA, *Auctores*.
LOPHOSPIRA, *Whitfield*. Amer. Mus. Nat. Hist., 1, 1886, p. 312.
LOPHOSPIRA, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 756. (See for full bibliography).
LOPHOSPIRA, *Ulrich and Scofield*. Geol. Minn., 3, pt. 2, 1897, pp. 951-960.

The description, as given by Ulrich and Scofield, follows:

> Shells with more or less elevated spires; whorls closely coiled throughout or only in the upper part, the last often exhibiting a tendency to become disconnected; whorls angular on the periphery and bearing from one to five distinct carinae; central or peripheral keel strongest and most prominent, carrying the band, which is obtusely rounded, or more or less distinctly trilineate, with the median line heavier and more prominent than the other two; axis rarely, if ever, solid; an umbilicus, usually of very small size, nearly always present. Inner lip generally thickened, often slightly twisted, turning around the umbilicus so as to form a kind of hollow pillar. Outer lip more or less deeply notched, but the centre of the notch, which lies at the peripheral angle, is never prolonged into a slit. Surface markings parallel with the apertural edge; occasionally cancellated by fine spiral lines.

LOPHOSPIRA BEATRICE, *Foerste*

Plate 1, Figure 13.

MURCHISONIA BEATRICE, *Billings*. Geol. Surv. Can., Rep. 1863, p. 209.
LOPHOSPIRA BEATRICE, *Foerste*. Bull. Sci. Lab. Denison Univ., xvii, 1914, p. 310, pl. 2, figs. 8a, 8b.

LOPHOSPIRA BEATRICE, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 757.
LOPHOSPIRA *cf.* PERANGULATA, *Coleman*. XIIth Int. Geol. Cong., 1913, Guide Book, 6, p. 19.

This species belongs to the group of *Lophospira bowdeni* in which the spires are high and consist of from eight to twelve whorls, which are less angular than in the group of *L. perangulata*. As the present species is very closely related to the better known *L. bowdeni*, the revised description of that species given by Ulrich and Scofield is reproduced below:

> Height 40 to 70 mm., usually 45 to 50 mm.; apical angle of Tennessee types of species averaging about 27° but varying between the extremes of 26° and 30°; of the Lorraine group variety 30° to 34°; of the Richmond group from 25° to 28° for specimens from Trimble county, Kentucky, and 27° to 33° for those from Boyle county in the same state; volutions eight to ten, moderately angular, the peripheral band thick, convex, varying as to prominence, situated beneath the centre of the whorls; upper slope convex, sometimes obscurely carinated, in the upper half, more or less concave in the lower half; lower carina obscure, never sharp, often indistinguishable, the space above it to the peripheral carina generally a little concave; a minute umbilicus usually present, though in narrow specimens it is commonly covered by the reflexed inner lip; aperture subtriangular or irregularly quadrate, the outline depending upon the angle at which it is viewed; inner lip nearly vertical, generally exhibiting a small channel in its lower part. Surface with obscure undulations or unequal lines of growth. These are very strongly recurved toward the peripheral band, indicating a large and deep v-shaped notch in the outer lip. The band is distinctly convex, occasionally subangular in the middle, has obscure lunulae, and is bordered on both sides by a delicate raised line.
>
> The prominence of the peripheral band varies considerably. As a rule it is the most pronounced in specimens from the Richmond group and least in those obtained from the "Upper Nashville" of Tennessee and the Lorraine of Kentucky and Ohio. The apical angle also is variable, though fairly constant in specimens from a given locality and horizon. The Lorraine variety is the widest, the Trimble county Kentucky, and Tennessee specimens the narrowest.[1]

Foerste described *L. beatrice* (*op. cit.*) as follows:

> The *Murchisonia beatrice*, Billings, listed in the *Geology of Canada* in 1863 from the Rivière des Hurons is as good a species of *Lophospira* as many another form of this genus, although undoubtedly closely related to *Lophospira bowdeni*, Safford. The specimens figured by Safford represent one extreme of development, with apical angles of 27 to 30 degrees, and with 8 to 10 volutions of which 6 or 7 are usually preserved, the tip being broken off. The characteristic feature of this group of shells is the rather broad and convex peripheral band, situated slightly below the centre of the whorl, varying considerably in prominence but usually far less angular than in most species of this genus. Upper slope flattened or moderately concave toward the peripheral band, angulated or obscurely carinated where it curves into the rather deep sutural area. The lines of growth are strongly recurved toward the peripheral band, as in so many species of the genus. A lower carination or angulation usually obscure but sometimes fairly distinct, ending near the upper margin or the inner lip, is seen on the last volution of some specimens at hand but enough is preserved to indicate that it had essentially the same form as that of *Lophospira bowdeni*. The chief difference between *Lophospira beatrice* and typical *Lophospira bowdeni* consists in its larger apical angle, apparently averaging about 35 degrees but varying from 30 to 38 degrees. This produces a shorter shell, so that the greater number of specimens, in their present state of preservation, present only four or five volutions although the complete shells probably possessed seven or eight.

Although this species seems to occur in some abundance at certain horizons in the strata at Toronto, it is seldom that recognizable examples are found and really well preserved specimens have not yet been seen. Agreement with the type in details of ornamentation, lip-structure, etc., is therefore, inferred rather than observed. In general shape, apical angle, number of whorls, and outline of whorls, our specimens approach very closely the forms figured by Foerste. Plate 1, Figure 13, is drawn from our best specimen, but the lines of growth have been restored from impressions of other shells in the prevailing shale of the formation.

---

[1] Geol. Minnesota, 3, pt. 2, 1897, pp. 986, 987.

The specimen figured measures 34 mm. in height and 17.5 in maximum width. The apical angle is 38°: this is very constant in all specimens measured, as it has not been observed to exceed 40°.

LOPHOSPIRA BEATRICE PARVA, *var. nov.*

Plate 1, Figure 14.

In addition to the species which is herein ascribed to *L. beatrice* our rocks contain a closely related form differing only in size and in a somewhat stronger accentuation of the revolving band. At first sight one is naturally inclined to regard these specimens as young forms of *L. beatrice*; but they occur in considerable numbers on slabs of rock which do not show the larger form, leading to the inference that they represent a separate variety. This inference is strengthened by certain constant differences as follows: the whorls are usually five or six instead of eight and the coiling is freer and more graceful in character. The revolving band is more prominent, and is accentuated above and below by a slight, but well marked depression. All specimens are of nearly uniform size, the height being 17 mm., the width about 8 mm., and the apical angle 40° as in the type of species.

Locality.—Don brickyard, Toronto.
No. 1199 H.R., Royal Ontario Museum of Paleontology.

LOPHOSPIRA TROPIDOPHORA (*Meek*)

Plate 1, Figures 15 and 16.

PLEUROTOMARIA (SCALITES?) TROPIDOPHORA, *Meek.* Geol. Surv. Ohio. Pal., 1, 1873, p. 154, pl. 13, figs. 6a-c.
LOPHOSPIRA TROPIDOPHORA, *Cumings.* 32nd Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 969, pl. 41, figs. 2-2d.
LOPHOSPIRA MULTIGRUMA, *Ulrich and Scofield.* Geol. Minnesota, 3, pt. 2, 1897, p. 978.
LOPHOSPIRA TROPIDOPHORA, *Foerste.* Geol. Surv. Canada, Memoir 83, 1916, pp. 84, 116, 123, 130, 133, 135, 158.

Among the uncertain gastropods that appear only on the weathered surfaces of limestone layers are a few that are closely related to, if not identical with *Lophospira tropidophora.* Two of these forms are selected for description: both of them show fairly well the character of the spire, and one indicates the character of the inner lip. The shape of the aperture and the character of the outer lip or of the umbilicus is not shown by any of our forms. While specimens referable with any certainty to this species are very few, it is not to be understood that the species is of rare occurrence because many indications of this type of gastropod are met with on the surfaces of limestone layers.

Lophospira tropidophora is thus described by Meek:

> Shell rather small, obliquely rhombic in general outline, as seen in a side view; height somewhat greater than the breadth; spire conical, with an apical angle of about 70° to 90°; volutions four to four and a half, each flattened, or sometimes slightly concave above, with an outward slope from the suture to a prominent angle that passes around the middle of the body turn, and below the middle of those of the spire, to which it imparts a somewhat turreted appearance; suture moderately distinct, but not channeled; lower side of body volution sloping rapidly inward from the medial angle, a little below which there usually revolves an obscure, undefined ridge; aperture rhombic subquadrate. Surface nearly smooth, but sometimes showing, under a magnifier, very obscure lines of growth, that curve very strongly backward as they approach the angle around the middle of the body volution, both above and below; thus indicating the presence of a deep sinus in the lip, widening rapidly forward, though there is no defined revolving band at the angle.
>
> Length or height, 0.55 inch; breadth, about 0.50 inch.

Ulrich in describing *L. multigruma* which is regarded as a synonym of *L. tropidophora,* says:

> Hight generally from 25 to 35 mm.; greatest width equalling from 75 to 80-100ths of the hight; apical angle 75° to 80°. Volutions five, uniangular; base produced, rounded; umbilicus closed; columellar lip thick and slightly twisted below. Surface markings curved strongly backward to the peripheral band, coarse and rather irregular on the base of the last whorl, much less distinct on the nearly flat upper slope. When perfect the lines of growth are somewhat lamellose.

The two specimens which have been selected to represent this species differ slightly from one another, one resembling Figure 37 and the other, Figure 39 of Ulrich, (*op. cit.*) ; both of these forms are figured herewith. Our specimens differ from the types in a negative, rather than in a positive manner, *i.e.,* there is no evidence of the character of the aperture, outer lip, or umbilicus, and the secondary ridge below the revolving band has not been observed.

The best preserved specimen is 20 mm. high, and 15 mm. wide, with an apical angle of 73.°

Locality.—Humbervale quarry, Toronto.
Nos. 1206 and 1236 H.R., Royal Ontario Museum of Paleontology.

Family TROCHONEMATIDAE

Genus CYCLONEMA, *Hall*

CYCLONEMA, *Hall.* Pal. New York, 2, 1853, p. 89.
CYCLONEMA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 330. (See for full bibliography).
CYCLONEMA, *Ulrich and Scofield.* Geol. Minnesota, 3, pt. 2, 1897, p. 1056.

The description given by Ulrich and Scofield follows:

> Shell turbinate or conical, never thick, composed of few more or less ventricose whorls; no umbilicus; surface sculpture consisting of numerous revolving lines and small ridges crossed obliquely by sharp lines of growth; aperture oblique; varying from rounded to subquadrate; inner lip more or less thickened, reflected, always excavated.

CYCLONEMA BILIX (*Conrad*)

Plate 1, Figure 17.

PLEUROTOMARIA BILIX, *Conrad.* Jour. Acad. Nat. Sci. Philadelphia, 8, 1842, p. 271, pl. 16, fig. 10.
PLEUROTOMARIA BILLIX, *Hall.* Pal. New York, 1, 1847, p. 305, pl. 83, figs. 4a-e.
CYCLONEMA BILIX, *Cumings.* 32nd. Ann. Rep. Dept. Geol. Nat. Res. Indiana, 1908, p. 958, pl. 40, figs. 2-2d.
CYCLONEMA BILIX, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 331.
CYCLONEMA BILIX, *Foerste.* Geol. Surv. Canada, Memoir 83, 1916, p. 75.

The description of this species as given by Hall is as follows:

> Obliquely conical; spire short, composed of four or more volutions, which are somewhat appressed above and ventricose below; last volution somewhat flattened on the lower side; aperture rounded, or slightly transverse; surface marked by numerous strong spiral carinae, which frequently alternate with finer ones; these are crossed by fine striae, which, commencing at the top of the volution, pass obliquely backwards to the base, or into the umbilicus, suffering no alteration of their direction upon the carinae.

The occurrence of this species at Toronto has long been accepted, but with the exception of one specimen from Weston (the highest of our strata) our collections show no evidence of the species. It would appear that the listing of *C. bilix* among the Toronto fossils is a survival of the time when "Hudson River" was made to include not only the Lorraine but the Richmond. The single specimen in our old collection said to be from Weston might be regarded as having come from Richmond float were it not that Foerste has recorded the species from that locality. *C. bilix* must therefore be recorded among our fossils, but it is extremely rare and in our experience has not been found elsewhere than at Weston. In fact we have not found a single specimen in our personal collecting.

The specimen figured is 20 mm. high and 21 mm. wide.

Locality.—Weston, Ontario.
No. 1212 H.R., Royal Ontario Museum of Paleontology.

CYCLONEMA, (?) *sp. indet.*

Plate 1, Figure 18.

There is, in our collection from the Don, a single internal cast of a small gastropod, which is too imperfectly preserved to assign to any particular genus. The specimen resembles both *Cyclonema* and *Holopea.* It has been mentioned and figured as an account of our gastropods would be incomplete without reference to this form.

Genus TROCHONEMA, *Salter*

TROCHONEMA, *Salter.* Geol. Surv. Canada, Org. Remains, Dec. 1, 1859, p. 24, 27.
TROCHONEMA, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 1299.

Salter's description of this genus follows:

> Turbinate, thin, of few angular whorls, marked by strong concentric ridges, and crossed by very oblique lines of growth. Umbilicus, wide, open. Inner lip thin, scarcely reflected; peritreme complete.

Ulrich and Scofield in redefining this genus lay stress on the following:

> Whorls not numerous (4-8), varying from strongly angular to rounded, always with two more or less prominent ridges or angles between which lies a broad vertical, usually flat or concave, peripheral space; a third ridge usually near the suture, while a fourth generally surrounds the umbilical cavity.

TROCHONEMA UMBILICATUM (*Hall*)

Plate 1, Figure 19.

PLEUROTOMARIA UMBILICATA, *Hall.* Pal. New York, 1, 1847, p. 43, pl. 10, figs. 9a-h; p. 175, pl. 38, figs. 1a-g.
PLEUROTOMARIA UMBILICATA, *Chapman.* Canadian Jour., n.s., 7, 1862, p. 121, fig. 124.
TROCHONEMA UMBILICATA, *Meek and Worthen.* Geol. Surv. Illinois, 3, 1868, p. 314, pl. 3, figs. 5a, b.
TROCHONEMA UMBILICATA, *Ulrich and Scofield.* Geol. Minnesota, 3, pt. 2, 1897, p. 1047, pl. 77, figs. 1-8.

Hall's description of this common species follows:

> Depressed, nearly discoidal; spire gradually ascending; width about equal to twice the height; spire short; volutions about four, angular and compressed above, ventricose below; suture canaliculated; aperture subrhomboidal, angulated anteriorly; umbilicus large and deep; surface marked with undulating striae.
>
> The last whorl is distinctly marked by three spiral ridges or carinations: one near the suture, one at the upper outer edge, and one at the lower outer edge, leaving the side of the volution plain and vertical; the upper side is angulated by the first carina, and the lower side rounded, scarcely ventricose; the lower angle of the last volution is covered by the spire, the two upper ones continuing. This fossil is readily distinguished, even in fragments, by the distinctly canaliculated suture, elevated upper carina, and the curvillinear depression between this and the next angle.

The occurrence of this species in the strata at Toronto has always been accepted, but, as far as our collections are concerned, it is safe to say that not a single specimen is of really certain identification. Nevertheless, the species in all probability does occur and in considerable abundance, for the shaly layers frequently show examples of a low-spired, thin-shelled, ridged gastropod with very fine lines of growth. These shells are invariably so compressed that their certain identification as *T. umbilicatum* cannot be said to be established.

Lacking any local material of sufficient perfection to assist in illustrating the species we have been forced to make use of the figures given by Ulrich and Scofield.

Suborder CONULARIIDA

Family CONULARIIDAE

Genus CONULARIA, *Miller*

CONULARIA, *Miller*. Sowerby's Min. Conchology, 3, 1821, p. 107.
CONULARIA, *Hall*. Pal. New York, 5, pt. 2, 1879, p. 205.
CONULARIA, *Cumings*. 32nd. Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 950.
CONULARIA, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 273. (See for full bibliography).

The peculiar Paleozoic organisms known as *Conularia* have been ascribed to various zoological groups. Following a more or less recognized practice, they are herein ascribed to the division *Pteropoda* of the *Gastropoda*. Later authorities, however, question this relationship and consider that *Conularia* is not a pteropod, but that it resembles more closely certain primitive cephalopods.

Cumings describes the genus as follows:

> Shell rectilinear, inversely conical, rectangular to rhombic in cross-section, with usually sharp edges, acute or truncated posteriorly. Each of the transversely striated or ribbed lateral faces divided into longitudinal halves by a superficial groove, corresponding internally to a median ridge. Posterior portion of the shell divided off by septa. Aperture constricted by four triangular or linguiform incurved lobes of the anterior margin.

CONULARIA FORMOSA, *Miller and Dyer*

Plate II, Figures 4 and 7.

CONULARIA FORMOSA, *Miller and Dyer*. Jour. Cincinnati Soc. Nat. Hist., 1, 1878, p. 38, pl. 1, figs. 12, 12a.
CONULARIA FORMOSA, *Cumings*. 32nd. Ann. Rep. Dep. Geol. Nat. Res. Indiana, 1908, p. 958, pl. 42, fig. 2.
CONULARIA FORMOSA, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 274. (See for full bibliography).

Miller and Dyer describe the species as follows:

> This species in general form is pyramidal, somewhat quadrangular, angles furrowed, and sides somewhat rounded as in *C. trentonensis*. The surface is marked by rounded furrows, separated by obliquely transverse ridges, extending from each angle of the shell diagonally towards the mouth, and meeting those from the opposite angle in the middle of each side. These ridges are ornamented with small nodes or tubercles at the junction with the striae, which cross the furrow on the side toward the apex of the shell. The rounded furrows are crossed by striae, which are about twice as numerous as the transverse ridges, and which terminate on the ridge toward the mouth of the shell in a small tubercle. The longitudinal striae do not cross the transverse ridges, nor are they continued in straight lines on the opposite sides (the magnified view is erroneous in this respect), but on the contrary the striae, which cross the furrows, commence at the ridge toward the apex, at a point between the tubercles, and crossing the furrow toward the mouth terminate at the tubercles.

Our collections contain but few specimens of this species, all from the Don brickyard, and all more or less fragmental. It is also recognized at a level of about 140 feet above Lake Huron in the section at Meaford.

The spacing of the transverse ridges varies from 5 or 6 in a mm. near the apex to 2 near the aperture. The longitudinal striae, where the transverse ridges are 3 to a mm., occur to the number of 5 or 6 in the same distance.

Locality.—Don brickyard.
No. 1215 H.R., Royal Ontario Museum of Paleontology.

CEPHALOPODA

Order NAUTILOIDEA

Suborder HOLOCHOANITES

Family ENDOCERATIDAE

Genus ENDOCERAS, *Hall*

ENDOCERAS, *Hall.* Amer. Jour. Sci. Arts, 47, 1844, p. 109; Pal. New York, 1, 1847, p. 58, p. 207 footnote.
ENDOCERAS, *Hyatt.* Text-Book Paleontology, Zittel-Eastman, 1900, p. 514.

In holochoanitic nautiloids the septal necks reach to the next septum apicad or even beyond. In the *Endoceratida* there are no "tabulae" in the siphuncle which is generally large and completely shut off from communication with the camerae.

In the family *Endoceratidae* the shells are smooth or annulated orthoceracones and the siphuncle is always more or less filled with organic deposits.

The genus *Endoceras* is thus restricted by Hyatt:

> Smooth or annulated orthoceracones. Funnels reach from septum of origination to the next apicad of this, but no farther. Septa pass entirely around the siphuncle. Organic deposits in the form of endocones, and taper off at the centre into a spire that is sometimes tubular and hollow, or again flattened and elliptical. This is the endosiphuncle.

The genus *Cameroceras,* Conrad, antedates *Endoceras* and was originally defined as possessing "a longitudinal septum, forming a roll or involution with the margin of the siphuncle." Hall found no evidence of this septum, and therefore erected *Endoceras* for related forms, leaving only the genotype *Cameroceras trentonense* in Conrad's genus. Later authors have come to regard the two names as co-generic; in consequence, the advocates of priority refer to *Cameroceras* the whole group of forms with long septal necks and endosiphuncular organic deposits. On the other hand the latest writers prefer to retain all these forms in the genus *Endoceras.*

ENDOCERAS PROTEIFORME, *Hall*

Plate IV, Figures 1-4.

ENDOCERAS PROTEIFORME, *Hall.* Pal. New York, 1, 1847, p. 208, pl. 46, figs. 1a-b, 2; 48, figs. 1, 4; 49, figs. 1a-e; 50, figs. 1-3; 52, figs. 1a-b; 53, fig. 1; p. 311; pl. 85, figs. 1a-f.
CAMEROCERAS PROTEIFORME, Clarke. Geol. Minnesota, 3, pt. 2, 1897, p. 777 pl. 48, figs. 1, 2; pl. 49, fig. 2; pl. 50, figs. 1, 2, 3?; pl. 51, figs. 1-3; pl. 53, figs. 4-5.
ENDOCERAS PROTEIFORME, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 483. (See for extended synonymy).

Hall's original description of this species was founded on specimens from the Trenton limestone: in the light of our present knowledge of the nautiloids this description is quite inadequate. The following quotation is the amended description given by Clarke (*op. cit.*):

> It may in a general way be said that *Endoceras proteiforme* is characterized by its enormous size, circular section, comparatively shallow air chambers and great submarginal siphon. The size attained by the species is best indicated by the large cast of the siphon, and entire shells referable to this species have been found with a length of ten to fifteen feet, though all the material before me is of smaller size. The difference in the aspect of these fossils at different parts of their length, where the siphonal tube is variously constructed and the septa subject to variations in distance, renders most appropriate the specific name *proteiforme.*
>
> One of the characters which is very helpful in distinguishing the siphonal casts of this from associated but rarer species of the genus, is the shortness of the siphonal

> funnels. The air chambers are themselves shallow, but the funnels seem at times not even to extend from one to the next. . . .
>
> The marginal or submarginal position of the siphuncle explains the obliquity of the septal annulations upon this tube, and the gentle incurvature of the septal funnels, the annulations of this tube.

In the Toronto rocks are numerous examples of large nautiloids with big marginal siphuncles. It has been customary to refer all these specimens to *Endoceras proteiforme.* In the great majority of cases the specimens are fragmentary, crushed, or otherwise distorted: it is impossible, therefore, to determine each individual specimen with any degree of certainty. Few, if any, of the Toronto specimens are sufficiently preserved to justify their use for descriptive purposes. Nevertheless, on the ground of the general resemblance of the fragments to this species we are inclined to refer them all to *E. proteiforme.* The specimens herein described were obtained from more compact layers of rock, presumably of about the same horizon, at Collingwood and in the township of Nottawasaga.

Our finest specimen (Plate IV, Figure 1) was obtained in the township of Nottawasaga. This specimen measures over all 1575 mm. in length. The width near the aperture is 171 mm. The width apicad is not discernible as the shell is much worn. As indicated in the figure the antisiphonal side apicad is much restored and is not reliable. The anterior end seems to be without septa and therefore to represent the body chamber. The condition of preservation of the surface, however, is not sufficiently good to justify the statement that septa are absent in this region. The posterior of this part representing a complete cast, shows three or possibly four sutures. Apicad, the shell and contained rock are broken away to the mid-line, thus exposing the siphuncle. Farther apicad, the siphuncle is broken open in three places exhibiting the characteristic endocones. Apicad of the last endocone, the siphuncle continues for some distance but is irregular, crushed, and devoid of any satisfactory detail.

The septa are strongly convex apicad and throughout the whole length in which they are visible do not seem to decrease materially in spacing, being about 34 mm. apart. The camerae appear to be quite empty. The siphuncular funnels extend to the next septum apicad but, without making a section, the detail of their structure cannot be seen.

The siphuncle anteriorly is 72 mm. wide and decreases gradually apicad. It is marked by diagonally disposed slight elevations just orad of the septal position, while a slight depression marks the general position of the camera. This diagonal marking of the siphuncle is, of course, the result of its marginal position.

The interior of the siphuncle is filled with endocones, observed where the structure is broken. How far orad these extend could not be ascertained without sacrificing the specimen. The apicad extension of the siphuncle is too uncertain to warrant any further remarks. (No. 1234 H.R.)

A second short, but well preserved fragment from Collingwood, (Plate IV, Figure 4), shows the following measurements:

Length	219 mm.	Width of siphuncle orad	80 mm.
Width orad	171 mm.	Width of siphuncle apicad	74 mm.
Width apicad	140 mm.	Average length of camera	27 mm.

The camerae vary in length; but this,, in part at least, is due to distortion. The septa run strongly forward to the suture giving the camerae a pinched appearance towards the periphery. The funnels turn apicad with an inward inflection, but immediately orad of the next septum they expand slightly and again contract to be inserted within the next neck to a distance of about 4 mm. This accounts for the diagonally annulated appearance of casts of the siphuncle. A vertical section was made through the siphuncle of this specimen, but no endocones were seen: it is probably situated too far orad. (No. 952 H.R.)

The best specimens actually found at Toronto consist of a few camerae with the siphuncle protruding apicad; they are always much flattened and seldom reveal any detail of structure. The example figured in Plate IV, Figure 3, is typical. The measurements of this specimen are as follows:

Length of camerae	85 mm.
Width (greatest diameter of flattened shell), orad	83 mm.
“ “ “ “ “ “ apicad	75 mm.
Width (lesser diameter of flattened shell), orad	50 mm.
Width (lesser diameter of flattened shell), apicad	40 mm.
Greater width of siphuncle	41 mm.
Lesser width of flattened siphuncle	18 mm.

A flattened specimen of this kind shows the variation in the length of the camerae, for with a width of shell of 110 mm. (flattened) the average length of the camerae is only 10 mm.

The species undoubtedly attained at Toronto a size comparable with that of the specimens described as we frequently find flattened fragments with a width up to 200 mm. Also fragments of siphuncles of a width as great as shown by the specimens referred to from Collingwood. One of these from Humbervale quarry has a length of 300 mm.

Endocones or perhaps the solid terminal part of siphuncles are of frequent occurrence. When well preserved these are smooth, apparently solid structures tapering to a sharp point. A good example from the Don quarry is 190 mm. long, and only 18 mm. wide at the large end.

Locality.—Nottawasaga, Collingwood, Humber river.
Nos. 1234, 952 and 1235 H.R., Royal Ontario Museum of Paleontology.

Family ORTHOCERATIDAE

Genus ORTHOCERAS, *Breynius*

ORTHOCERAS, *Breynius.* Dissertatio Physica de Polythalamiis, 1832, p. 12.
ORTHOCERAS, *Hyatt.* Zittel-Eastman Textb. Pal., 2nd. ed., 1913, p. 598.

The description of this genus given by Hyatt (*op. cit.*) is as follows:

> Long tapering orthoceracones and cyrtoceracones, smooth, or with only transverse striae and growth bands. Siphuncle generally larger than in *Geisonoceras*, centren or slightly dorsad of centre. Deposits when present gathered about the funnels as in *Annulosiphonata.*

It would appear that the shape of the siphuncular segments alone will not serve to differentiate *Orthoceras* and *Actinoceras* but rather the presence of an endosiphuncle with radiating tubuli in the latter genus.

The definition of "nummuloidal" is insufficient: the term is generally considered to be applicable if the structure is wider than long, but species confidently ascribed to *Orthoceras* have nummuloidal siphuncles within this meaning of the word. See discussion under *Actinoceras,* page 20.

ORTHOCERAS DUSERI, *Hall and Whitfield*

Plate IV, Figures 7 and 8.

ORTHOCERAS DUSERI, *Hall and Whitfield.* Geol. Surv. Ohio, Pal. 2, 1875, p. 97, pl. 3, figs. 2-4.
ORTHOCERAS FOSTERI, *Miller.* Cincinnati Quart. Jour. Sci., 2, 1875, p. 127.
ORTHOCERAS FOSTERI, *Miller.* Jour. Cin. Soc. Nat. Hist., 4, 1881, p. 319, pl. 8, 7, 7a.
ORTHOCERAS DUSERI, *James.* Jour. Cin. Soc. Nat. Hist., 8, 1896, p. 241.
ORTHOCERAS DUSERI, *Foord.* Cat. Foss. Ceph. Brit. Mus., 1, 1888, p. 14.

ORTHOCERAS DUSERI, *Lesley*. Geol. Surv. Penn., Rep. P4, 1889, p. 548.
ORTHOCERAS DUSERI, *Cumings*. 32nd. Ann. Rep., Dept. Geol. Nat. Res. Indiana, 1908, p. 1036, pl. 52, figs. 2-2b.
ORTHOCERAS DUSERI, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 904.

The description given by Hall and Whitfield is as follows:

> Shell of medium size, rather rapidly and gradually enlarging from below upwards, the diameter increasing to twice the size in the space of four and a half inches. Transverse section circular; length of the outer chamber not determined. Septa moderately concave, and closely arranged, but gradually increasing in distance with the increased size of the shell—six chambers occupying the space of one inch where the diameter of the shell is one and a half inches at the upper one of those measured; nearer the point there are ten to twelve in the same distance where the diameter is only three-fourths of an inch. Siphuncle eccentric situated a little nearer to the center than to the margin; very small where it passes through septa, but expanding within the chambers to about four times its diameter at the other point, and forming a flattened bead-like body within each chamber.
>
> Surface of the shell apparently smooth, except that the edges of the septa are raised above the general level, in the form of narrow rings. This feature may possibly be due, in part at least, to an expansion of the septa during the process of petrifaction, but it would scarcely seem to be the case, as the feature is too regular, and only shows where the external shell is wholly or partly preserved. The rings are often some little wider on the surface than the thickness of the septa. Where the surface is most perfectly preserved there is also a finely reticulate or net-like character, dividing the surface into small rhombic figures of microscopic dimensions, having their longest diameters corresponding to the length of the shell, and presenting a surface similar to that frequently produced by the attachment of bryozoans; but the regularity is so great that this cannot have been the origin of the feature; neither have the rhombs anything like a radial structure or direction in any part, as would have been the case if they were the result of the growth of a bryozoan. Along one side of the shell and directly opposite to the position of the siphuncle, there is a narrow, raised, longitudinal line, extending the entire length of the tube, but slightly interrupted just above each one of the annular rings.

Foord (*op. cit.*) makes the following statement:

> Section circular or elliptical (? by pressure) enlarging rather rapidly at the rate of about 1 in 6. Septa closely approximate, but increasing gradually in distance with the growth of the shell, so that they are about one line apart where the shell has a diameter of 5 lines, and about 1½ lines where the diameter has increased to 10 lines, and so on. . . .
>
> Messrs. Hall and Whitfield describe the surface of the shell in *O. duseri* as follows: It has a finely reticulate or net-like character, 'dividing the surface into small rhombic figures of microscopic dimensions etc.' I think these appearances are due to an encrusting Monticuliporoid Coral (Bryozoan), of which I find traces adhering to the specimen in the National Collection.

Foord makes no reference to the external vertical raised line mentioned by Hall and Whitfield.

There seems to be some discrepancy between the statements of these authors as to the rate of increase in diameter. The statement that the shell doubles in diameter in 4½ inches is evidently useless unless the actual diameter is given. Hall and Whitfield's figure, however, shows an increase of 1 in 5.5, which is not essentially different from the figure given by Foord.

We have been unable to find a figure or description accurately defining the siphuncle in this species. In order to ascertain this feature we have cut a typical specimen of *O. duseri* from the Waynesville of Clarksville, Ohio, presented by Dr. Foerste. This specimen corresponds closely with the description of the type, shows the vertical raised line on the antisiphonal side, is encrusted with *Paleschara beani*, and has the siphuncle distinctly excentric in position, and without internal thickenings. The siphuncular segments are moniliform or perhaps nummuloidal as they are distinctly wider than long and the maximum diameter is orad of the mid-length.

The following measurements indicate the character of the camerae and of the siphuncular segments in dorso-ventral section.

Larger end.

Width	20 mm.
Length of camera and siphuncular segment	3.7 mm.
Width of siphuncular segment	5.2 mm.
Ratio of length to width of segment	1: 1.4

Smaller end.

Width	16 mm.
Length of camera and siphuncular segment	2.7 mm.
Width of siphuncular segment	3.7 mm.
Ratio of length to width of segment	1: 1.3

It will be observed that the segments are relatively wider orad. This specimen (No. 12093) is shown in Plate IV, Figure 7.

Hitherto the presence of the "raised line" has been considered sufficient evidence on which to ascribe a specimen to *O. duseri*: this peculiarity is really of no value as it is shown by many other species of *Orthoceras* (See page 22). The slight protrusion of the septal edges in decorticated specimens is also of little value. Without cutting sections, we have only the somewhat closer spacing of the septa as a practical means of separating this species from *Actinoceras crebriseptum*. In sections the species is easily differentiated by the wider siphuncular segments and the absence of the characteristic thickenings of *A. crebriseptum*.

The Toronto specimens ascribed to *O. duseri* are fragments only, but they seem to agree very closely. The antisiphonal line is well marked: the segments of the siphuncle are empty, and correspond closely to those of the specimen from Ohio described above. The spacing of the septa is a little wider than in the Ohio type. A typical fragment is shown in transverse section in Plate IV, Figure 8. In comparing this figure with Figure 7, one must remember that the sections are at right angles to one another.

Locality.—Humber River, Weston, 10 feet below base of scarp on east side. No. 1223 H.R., Royal Ontario Museum of Paleontology.

ORTHOCERAS LAMELLOSUM, *Hall*

Plate IV, Figure 6.

ORTHOCERAS LAMELLOSUM, *Hall*. Pal. New York, 1, 1847, p. 312, pl. 86, figs. 2a-e.
ORTHOCERAS LAMELLOSUM, *Chapman*. Can. Jour., n.s., 8, 1863, p. 20, fig. 127.
ORTHOCERAS LAMELLOSUM, *Chapman*. Expos. Min., Geol. Canada, 1864, 128, fig. 127, p. 172, fig. 192.
ORTHOCERAS LAMELLOSUM, *Nicholson*. Rep. Pal. Prov. Ont., pt. 11, 1875, p. 36, fig. 12b.
ORTHOCERAS LAMELLOSUM, *Ami*. Trans. Ottawa Field Nat. Club, 1, 1882, p. 65.
ORTHOCERAS LAMELLOSUM, *Foord*. Cat. Foss. Ceph., Brit. Mus., 1, 1888, p. 14.
ORTHOCERAS LAMELLOSUM, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 909.
ORTHOCERAS LAMELLOSUM, *Foerste*. Geol. Surv. Can., Mem. 83, 1916, p. 8.

Hall described this species in a very inadequate manner, and as far as we have been able to ascertain, nothing has been published to add any essentials to the original description. It is quite impossible to determine the species by use of the available publications. Nevertheless, *O. lamellosum* has long been recognized as a fossil of frequent occurrence in our rocks. The form to which this name has been given is herein described as *O. lamellosum*; it is undoubtedly different from the other species in our rocks, but that it is really the *O. lamellosum* of Hall is uncertain.

Hall's description follows:

> Slender, very gradually tapering to an acute point; septa distant from one-fifth to one-fourth of an inch, having a convexity about equal to their distance from each other; siphuncle slightly excentric; surface apparently lamellose or subimbricate.

Our collections show several examples, lacking the shell, which externally at least are closely similar to *A. crebriseptum,* but in which the apical angle seems to be larger. These casts also show a distinct antisiphonal raised line as in many specimens of *A. crebriseptum.* This feature seems to have little or no specific value as it is known in a number of species: it is more fully considered on page 22.

The species is represented in our collections by fragments only. The surface is in no case preserved. On the cast the septal edges are markedly even, horizontal and parallel with gradually increased spacing orad. On the antisiphonal side is a "raised line," finer and narrower than in *O. duseri* or *Actinoceras crebriseptum,* and yet quite clearly defined. The siphuncle is somewhat excentric in position, without thickenings of any kind: it is moniliform in shape, but distinctly narrower than in *A. crebriseptum* and much narrower than in *O. duseri.* The available specimens indicate a larger apical angle than in the species mentioned above, but the fragments are too short to justify a definite statement. Measurements of two of our best species are given below:

Length .	43 mm.	36 mm.
Width, orad	29 mm.	33 mm.
Width, apicad	24 mm.	28 mm.
Rate of taper	1 in 8	1 in 7
Average length of camera	4.7 mm.	5.5 mm.
Ratio, length to width of camera	1: 5.6	1: 5.5
Ratio, width to length of siphuncular segments	1: 1.3	1: 1.4

Unfortunately these specimens were, by mistake, cut transversely instead of dorso-ventrally: in consequence, the figure of specimen "B" given herewith shows the siphuncle as central in position. The width also is slightly less than indicated by the figures above.

Locality.—Prison quarry, Mimico.
No. 1233 H.R., Royal Ontario Museum of Paleontology.

Family ACTINOCERATIDAE

Genus ACTINOCERAS, *Bronn*

Actinoceras, *Bronn.* Lethaea Geognostica, 1837, Zweite Aufl. Band 1, p. 97.
Actinoceras, *Foord.* Cat. Foss. Ceph. in Brit. Mus., pt. 1, 1888, p. 164.

The genus *Actinoceras* seems to have been established by Bronn and Bigsby's figures published in the Transactions of the Geological Society of London. Stokes accepts Bronn's genus with certain emendations: Barrande discusses in detail the various opinions as to the validity of the genus *Actinoceras.* Most modern writers accept the genus.

The original description of *Actinoceras,* quoted by Barrande is as follows:

> Siphuncle very large, articulated, composed of flattened spheroidal elements with internal rays.

Stokes' definition of the genus is as follows:

> The character of the genus *Actinoceras* is a large siphuncle much dilated in each chamber and contracted at the points where it crosses the septa. In the interior of this siphuncle there is a continuous tube which seems to have been capable of contraction and expansion and (sometimes at least) provided with vertical rays uniting this tube to the walls of the siphuncle.

L. Saemann gives a long dissertation on the nature of *Actinoceras* adopting the opinions of both Bronn and Stokes: *i.e.,* the genus is defined as having expanded siphuncular segments and also internal vertical rays.

This general conception is shared by many authors including Woodward, Roemer, and Eichwald, the latter of whom admits that the radiating lamellae may be replaced by radiating tubes. Barrande, after reviewing the evidence to his time, seems to have been in doubt as to the validity of the genus *Actinoceras*.

Barrande, however, draws attention to an organic thickening of the interior of the siphuncle which usually begins as an annular ring around the necks of the septa and may so extend as to fill the whole of the siphuncular segment not occupied by the endosiphuncle and its tubuli. These organic thickenings were termed by Barrande "anneaux obstructeurs." They are particularly well developed in the *Actinoceratidae,* but are admitted also in the *Orthoceratidae.*

In the practical differentiation of *Orthoceras* and *Actinoceras* several difficulties arise. (*a*) The limitation of *moniliform* as compared with *nummuloid*: *i.e.*, the ratio of the length to the width of the swollen siphuncular segment. It would appear that the segment should be wider than long in order to be described as nummuloïdal, but nevertheless many forms are ascribed to *Actinoceras* in which the siphuncle could not be called nummuloidal according to this definition of the term. In doubtful cases, therefore, the shape of the siphuncular segment cannot be relied on to separate *Actinoceras* and *Orthoceras.* (*b*) With regard to the *anneaux obstructeurs*; it is evident from what has been said above that this feature will not serve to differentiate the two genera as these thickenings occur in both, although more strongly developed in *Actinoceras.* (*c*) *Actinoceras* must depend, therefore, on the presence of an endosiphuncle with its radiating lamellae or tubuli: the preservation of these structures is often very imperfect and they are sometimes absent as the calcifications diminish orad and completely disappear in the most anterior segments of a large shell.

Foord's description of the genus follows:

> Shell attaining to a very large size in some species; straight; elongate-conical. Section circular to subcircular. Septa usually more arcuate than in *Orthoceras;* the necks very short and recurved, and often with crystalline deposits ("the anneaux obstructeurs" or "dépôt organique," of Barrande), which sometimes fill the spaces in the siphuncular cavity not occupied by the endosiphon and its canals. Siphuncle very large, the diameter sometimes equalling half that of the shell; much inflated between the septa, so as to present a series of segments of a compressed-globular form. The shelly covering of these segments, which is composed of several layers, is very rarely preserved. The calcified lining membrane of the siphuncle is thrown into a series of folds which impart to it a puckered appearance which is very characteristic. The endosiphon is provided with a distinct wall, and gives off at regular intervals between the septa a number of radiating canals or tubuli, which apparently penetrate the shelly covering or wall of the siphuncle, and, if so, they may have served, as suggested by Owen, for the passage of blood-vessels to the lining membrane of the septal chambers. The spaces between the tubuli are sometimes filled up so that curved transverse partitions, which are formed originally in membrane, and are convex anteriorly, divide the siphuncle into a series of loculi. Nothing is seen of these partitions when the siphuncular cavity has been filled with calc-spar.
>
> The first segment of the siphuncle is in the form of a broadly conical chamber, perforated above the apex by a large foramen, through which the endosiphon passed from the initial chamber into the siphuncular cavity.

ACTINOCERAS CREBRISEPTUM (*Hall*)

Plate II, Figures 2 and 3; Plate III, Figures 1-9.

ORMOCERAS CREBRISEPTUM, *Hall.* Pal. New York, 1, 1847, 313, pl. 86, fig. 2a; pl. 87, figs. 2a-e.

ACTINOCERAS CREBRISEPTUM, *D'Orbigny.* Prodr. Pal. 1, 1849, p. 3.

ORTHOCERAS CERBRISPTUM, *Billings.* Geol. Surv. Can., Rep. 1863, p. 218, fig. 228.
ORTHOCERAS (ORMOCERAS) CREBRISEPTUM, *Barrande.* Syst. Sil. du Centre Bohême, 2, pt. 3, 1874, p. 739, pl. 434, figs. 6-8.
ORMOCERAS CREBRISEPTUM, *Nicholson.* Pal. Prov. Ont., 1875, p. 37.
ACTINOCERAS CREBRISEPTUM, *Foord.* Cat. Foss. Ceph. Brit. Mus., 1, 1888, p. 173.
ORTHOCERAS CREBRISEPTUM, *Chapman.* Minerals and Geology of Ontario and Quebec, 1888, p. 211, fig. 233.
ORTHOCERAS CREBRISEPTUM, *Chapman.* Outline Geol. Canada, Introduction, p. xxv, pl. IV, fig. 52.
ORTHOCERAS CREBRISEPTUM, *Coleman.* Nat. Hist. of Toronto Region, 1913, p. 61.
ORTHOCERAS CREBRISEPTUM, *Coleman.* XIIth. Int. Geol. Congress, Guide Book No. 6, 1913, p. 10.
ACTINOCERAS CREBRISEPTUM, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 12.

This species has been the subject of considerable discussion particularly as its generic reference is still open to question. Hall's original description is as follows:

> Elongated, conical, somewhat rapidly tapering to an acute apex; septa numerous, approximate, deeply arched, distant about one-seventh the diameter; siphuncle excentric, enlarging in each cell and contracting at its passage through the septum; section circular; surface marked by longitudinal lines, which are visible in the cast.

The best description of this species is given by Barrande (*op. cit.*) and is founded on a specimen from the Hudson River formation of Canada identified and sent to him by Billings. Barrande's remarks are quoted somewhat fully below:

> It is not necessary to discuss here the specific determination of the fossil which we figure and which is composed of a series of air chambers, exposed in a longitudinal section. The authority of Mr. Billings satisfies us on this point.
>
> One may see from this fragment that the shell is elongated. But, as most of the chambers are broken on the right side, the apical angle which appears to be about 2° near the small end may have been modified by compression. The cross section is circular.
>
> The suture is almost horizontal but this statement must not be taken without doubt. The spacing of the septa is somewhat irregular—between 3 and 7 mm. in the 18 chambers observed. The curvature can be considered as about one-fifth of the corresponding diameter. . . .
>
> It may be observed towards the lower end of the fossil which appears to be the best preserved that the lines representing the sections of the septa indicate a breaking on the right of the siphuncle, for they do not form complete curves.
>
> In the space corresponding to the air chambers on the right side the débris of the septa may be observed. Each piece is covered on both sides by a thin layer of white silica which also extends around the ends. We find these same layers on the perfect septa towards the lower end of the fossil. This appearance, together with that of the rock which occupies the whole space indicates sufficiently the absence of an organic deposit in this part of the *Orthoceras.* As it is relatively the larger part with respect to the siphuncle it would seem, on the contrary, the most disposed to reveal this deposit.
>
> But, in the part to the left of the siphuncle, we observe a ribbon-like deposit of a chemical nature which might be misinterpreted as to its origin. However, as this structure is formed in the same manner as the siliceous layer which covers immediately all the surfaces of the air chambers and that of the siphuncle, we can consider it only as derived from an inorganic source. We see that this deposit, well indicated in the seven lower chambers, disappears in the upper chambers.
>
> The siphuncle, placed off the axis at the small end, is excentric throughout the whole length, and its excentricity diminishes gradually towards the top. One could even predict that in a longer specimen the siphuncle would attain a central position near the larger end. It would also become submarginal near the small end. We have noticed a similar obliquity of the siphuncle with respect to the axis of *Orthoceras* in different species of Bohemia.
>
> The elements of the siphuncle are a little cordiform, *i.e.*, their width at the summit is greater than at the base. They are also a little oblique on account of the marked excentricity. The maximum diameter does not reach 6 mm. and the corresponding height 7 mm. Thus they approach nearer to the cylindrical than to the nummuloidal form in the upper part of the fragment. On the contrary, towards the lower end, the height and the width tend to become equal in each element.

> The organic deposits seem to be represented in the eight lower elements, but in an unusual form, which we have not hitherto seen in any other species except *O. palemon* of Bohemia. The unusual feature in the occurrence of this deposit is that it is formed on one side only of the siphuncle—the left in the figure. Their section pyriform, elongated, and a little irregular extends from the neck throughout the whole length of the element. We see, on the contrary, no trace of this deposit on the opposite wall. This distribution seems to be the extreme limit of a generally observed occurrence, for *l'anneau obstructeur* is always more developed on one side of the siphuncle than on the other.
>
> The specimen described has a length of nearly 106 mm. Its diameter at the small end is about 21 mm.
>
> The elements of this species which we know do not permit us to compare it in detail with analogous forms from the same country. We have nothing in Bohemia which can be considered as closely related to it.

It has been a common practice to ascribe to this species most of the specimens of *Orthoceras* found at Toronto. As nearly all specimens are imperfect and very seldom retain the external shell, one is generally unable to make use of the characteristic vertical lining as a means of determination. The mere spacing of the septa and the rate of tapering are of doubtful value, especially in fragmentary material. Further, as the identity of the species depends so much on the peculiar character of the siphuncle and internal thickenings, it becomes necessary, practically in each case, to prepare a section through the shell. Many specimens show the characteristic features as described by Barrande with the one exception that the siphuncle does not tend to become central towards the aperture. On the contrary, it seems in most cases to become more excentric.

A feature of many specimens of *A. crebriseptum* is the presence of a more or less marked antisiphonal raised line on casts of the interior. Unfortunately this peculiarity is of little use for the identification of the species as it is seen also in *Orthoceras duseri* and *O. lamellosum* from our rocks.

This raised line is given prominence by Barrande in all his descriptions of Paleozoic cephalopods and is discussed in detail in Chapter XIII, Vol. II, Pt. V, Systême Silurien de la Bohême. The appearance is called *la ligne normale* and is thus described by Sandberger:

> *La ligne normale*, which we find very clear and distinct in *Bactrites gracilis* and *B. subconicus*, and also in a great number of species of *Orthoceras*, shows itself on the surface of the internal mould of these fossils as a longitudinal keel more or less clearly marked. Its form varies in different species, for it is sometimes simple, sometimes multiple; thus, it is triple in *Orthoceras undatolincolatum*. According to the state of preservation and the nature of the fossilizing substance, it is sometimes visible on all the chambers, or it appears, on the contrary, only here and there on certain ones.

It would appear from Barrande's conclusions that this line is individual rather than specific; that it is sometimes a raised line (carène) or a depressed line (en creux); that it sometimes shows on the living chamber only, and sometimes only on the camerae; and that it may be either siphonal or antisiphonal in position.

La ligne normale was observed in 61 out of 525 species of *Othoceras* from the Silurian rocks of Bohemia and in 77 out of 1,014 species of cephalopods.

Many specimens of *A. crebriseptum* show this line on the camerated part of moulds; we have not observed it on the body chamber. It is frequently absent but this may be only accidental as all such specimens are of necessity more or less imperfect.

The most typical *A. crebriseptum* in our collections is a fragment 80 mm. long, 20.5 mm. wide at the larger end, and 12.5 mm. at the smaller end. The shell is intact and quite smooth on the siphonal side, but with well marked longitudinal striae on the antisiphonal side; these extend about one-third of the total circumference of the shell. (Plate II, Figure 3).

In the ten camerae at the small end the septa average 3.2 mm. apart. The ratio of length to width is therefore 1: 5. The siphuncle is slightly excentric apicad and tends to become more so orad.

The siphuncular segments (Plate III, Figure 4), are moniliform in shape and slightly longer than wide. Assuming the siphuncle to be ventral in position (right in figure) the organic deposits within this structure seem to be confined to the ventral side and to be less developed orad. Unlike other specimens, this example shows a hollow within the thickenings which is filled with crystalline calcite. The remaining parts of the siphuncle are filled with clay (dotted). It will be noted that these organic deposits do not exactly correspond with those described by Barrande; they are similar, however, in being related to the ventral side.

The camerae on the siphonal side are completely filled with a dense sort of calcite which sometimes displaces the septa: it is arranged in a botryoidal manner and evidently was formed from shell inwards. This type of filling extends to the antisiphonal side, but here it is slightly developed forming a lining on the inner side of the shell proper and extending a short distance inward on the orad side of the septa (lined in figure). From the evidence derived from this specimen and from that furnished by others described below, it would appear that this material is inorganic in origin, formed after the death of the animal, but occasioned by some organic substance within the camerae which was largely confined to the ventral side.

The four apicad septa on the antisiphonal side were filled with clay (dotted) immediately after the deposit described above was formed. The fifth was only partly filled with clay. Those camerae into which clay did not find its way—the four orad camerae—were lined with a thin layer of fine fibrous calcite, and at a later time, the interiors were filled with crystalline calcite of the same character as that which fills the space in the centre of the siphuncular thickenings. (No. 1225 H.R.)

A second specimen with the test preserved (Plate III, Figure 8), consists of a fragment near the apex: it is about 44 mm. long; 18 mm. wide orad, and 12 mm. wide apicad. There are 12 camerae giving an average length of 3.7 mm., and a ratio length to width of 1: 3.6. This specimen has the septa more widely spaced than in the form described above: in consequence, the siphuncular segments are more elongated. The figure shows a transverse, instead of a dorso-ventral section. The inorganic thickenings in the camerae appear, therefore, in a marginal position on the outer sides of the camerae. The organic thickenings within the siphuncle present more the appearance of rosettes over the septal necks, and show also, orad at least, the endosiphuncular space. The unoccupied parts of both siphuncle and camerae are filled with a dense, partially silicified calcite (vacant in figure). The fibrous layer, however, can be made out in places.

This example bears a striking resemblance, in spacing of septa, and in the shape of the siphuncular segments to *Orthoceras mohri*, Miller. In view, however, of the characteristic thickenings, it seems impossible to remove it from *A. crebriseptum*. (No. 1230 H.R.)

Another somewhat similar specimen is shown in Plate III, Figures 7 and 7a. Figure 7 represents a transverse section, and Figure 7a, a dorso-ventral section of the siphonal side. The fragment is 40 mm. long, 17 mm. wide orad, and 10 mm. wide apicad. There are 15 camerae, giving an average length of 2.6 mm. and a ratio of length to width of 1: 5.2. In regard to the spacing of the septa, therefore, there seems to be some variation, as these three specimens, approximately of the same size, show respectively a spacing of 3.2 mm., 3.7 mm., and 2.6 mm.: but, reduced to the ratio of length to width, the difference is less apparent, *i.e.,* 1: 3.6 to 1: 5.2.

This specimen is of particular interest in that it shows in a most defined manner the inorganic thickening in the camerae. In the transverse section it appears on both sides as clear structureless calcite lining the external wall of the camerae and extending inwards on the orad side of the septa (dotted in figure). On the siphonal side (Figure 7a) it is much thicker and botroyoidal in structure. The camerae which have been filled with clay (crosses in figure) show a sharp definition of the boundaries of this inorganic layer. All other open parts are lined with the fibrous layer and filled with crystalline calcite as in the other cases.

The siphuncle is not well preserved, indistinct thickenings only being observed. In the figure it is indicated as being entirely filled with clay. (No. 1229 H.R.)

The three specimens described above are all small and represent either young individuals or the apical end of larger individuals, more likely the former. The larger fragments are described below.

One very typical example is shown in dorso-ventral section in Plate III, Figure 2. The fragment is 46 mm. long, 21 mm. wide at the large end, and 14 mm. wide at the small end: it contains 13 camerae which increase in length orad but not regularly. The average length of a camera is 3.5 mm., and the average width is 17.5 mm. The ratio of length to width is, therefore 1: 5.

The shell is not preserved; it appears to have been very thin as likewise the septa and the siphuncular sheaths. The siphuncle is but slightly excentric—less so than in some other examples.

This specimen reveals essentially the same features which have been described in the case of No. 1225 H.R. The chief difference is that the siphuncular thickenings do not exhibit an internal cavity. This organic thickening, however, is very dense and badly preserved in this instance: the lining shown in the figure is much overdrawn. The secondary character of the calcite on the siphonal side (left in figure) of the camerae is indicated by the fact that the septa are broken by the growth of this matter. It is also to be observed that the calcite has formed around certain centres as in the case of small particles of clay adhering to the septa in places. On the antisiphonal side a thin layer of similar calcite (lined in figure) formed on the outer wall of the camerae and extended inwards on the orad side of the septa. Where infiltered with clay the camerae show no fibrous layer. Where there is no clay the fibrous layer occurs and the centre of the space is either empty or filled with crystalline calcite.

Locality.—Prison quarry, Mimico.
No. 1219 H.R., Royal Ontario Museum of Paleontology.

Another fragment, also without either striae or raised line, shows relatively longer camerae than the example just described and seems to indicate a trace of an endosiphuncle.

This fragment is 25 mm. long and shows six camerae in that distance; the maximum width is 20 mm. and the minimum 15 mm. The average camera is 4.2 mm. long and 17.5 mm. wide; the ratio of length to width is, therefore, 4.2:

17.5, which equals 1: 4.2. The section was cut to pass through the siphuncle (Plate III, Figure 5) in a plane at right angles to the dorso-ventral; in consequence, the siphuncle appears central and the camerae on both sides present the same features. It would appear that the inorganic ventral calcification in the camerae extends above the midline as it appears towards the outer walls on both sides and increases in amount apicad. The thin fibrous calcification is evidently later. The interesting point revealed by this specimen is the trace of a distinct endosiphuncle which has a tubular appearance in the first four segments orad; it seems to effect a communication with the camerae in the second section from the anterior end. In the two apicad segments its identity is lost. In the drawing, the clay filling the endosiphuncle is figured as in the case of the filling of the camerae (fine dotted). The clay filling of the rest of the siphuncle is more coarsely dotted and whilst diagrammatic, it nevertheless expresses the fact of a different texture being apparent in the two parts. (No. 1220 H.R.)

Another very good specimen (Plate III, Figure 3) showing the structure towards the small end and the gradual loss and final disappearance of both the siphuncular and ventral thickening orad is described below. It is unfortunate that this specimen, also, shows neither striae nor raised line externally as the shell is lost.

This is an excellently preserved fragment 66 mm. long, 23 mm. wide at the larger end and 14 mm. wide at the small end. It contains 20 camerae. The average length of a camera is, therefore, 3.3 mm., and the average width is 18.5 mm. The ratio of length to width is 3.3: 18.5. *i.e.,* about 1: 5.6.

The section is cut in the dorso-ventral plane and shows that the siphuncle in this case is but slightly excentric; further, it does not seem to become more central towards the aperture. This specimen shows in a marked manner the difference between the antisiphonal and siphonal filling of the camerae. The ventral calcification already referred to, seems to fill the whole of the three apicad segments. This, however, is unexpected and may possibly be due to the inability to differentiate different types of calcite. On the antisiphonal side it could as well be interpreted as an unusual development of the fibrous layer. From this point forward the ventral calcification is restricted to the ventral side and fills all the space between the walls, septa, and siphuncle as far forward as the sixteenth camera inclusive. Orad of this it gradually decreases in amount, being confined to the side towards the shell; the remainder of the ventral part of the camera being filled with clay.

On the antisiphonal side of the siphuncle, excepting the three apicad segments, the camerae are lined with the fine fibrous layer already referred to, and variously filled with clear crystalline calcite. The extension of the ventral type of calcite as a thin layer on this side is not observed as the peripheral part of the specimen has been eroded.

The siphuncle is identical in shape with that of the specimens already referred to. The average maximum width of the moniliform segments is 3.2 mm. and the length 3.3 mm. They are, therefore, slightly longer than wide.

The organic thickenings within the siphuncle are excellently shown. They are confined to the ventral side and decrease in amount orad, disappearing with the sixteenth segment except for a minute occurrence in the seventeenth.

This siphuncular thickening shows very indistinctly the ribbon-like character ascribed to these structures. In places there is a slight indication of "rosettes" but on the whole it is more of a wavy and indistinct character. This feature is rather overdrawn in the figure.

Locality.—Prison quarry, Mimico.
No. 1221 H.R., Royal Ontario Museum of Paleontology.

In all our collections we have only one specimen that shows the body chamber (Plate III, Figure 1): it is about 185 mm. long in all: the body chamber is 56 mm. in length. The chambered portion shows 27 camerae varying somewhat in length at the smaller end, but becoming distinctly more closely spaced towards the aperture. The specimen is bent and flattened; in consequence the rate of tapering as shown in the drawing may not be quite accurate. The outer shell is absent, leaving us in doubt as to the occurrence of striae externally. In places there is a faint indication of a "raised line." A section of the lower part of this specimen shows the internal structure typical of the species, but the siphuncle is more markedly excentric.

Locality.—Humber River, Toronto.
No. 941 H.R., Royal Ontario Museum of Paleontology.

The specimen above described seems to have reached its maximum growth as indicated by the crowding of the septa near the living chamber; nevertheless, we find broken pieces of larger size which must be provisionally ascribed to this species. As they are all orad of the region of siphuncular thickening the shape and spacing of the elements alone indicate a reference to *A. crebriseptum,* but the position of the siphuncle in no case shows the approach to the centre mentioned by Barrande.

One of the best fragments of this kind (Plate III, Figure 9) gives the following measurements:

Length	80 mm.
Width at larger end	44 mm.
Width at smaller end	29 mm.
Average length of camera	6.1 mm.
Ratio of length to width of camera	1:6

This specimen might as well be ascribed to *O. lamellosum.*

Locality.—Prison quarry, Mimico.
No. 1222 H.R., Royal Ontario Museum of Paleontology.

As already stated many internal casts show a distinct longitudinal "raised line" on the antisiphonal side. Hitherto we have been accustomed to ascribe such forms to *Orthoceras duseri,* but the examination of a great many longitudinal sections prove that these forms differ in no way from *A. crebriseptum.* Without sections it is difficult to separate the two species, but in good specimens the present species may be differentiated by the wider spacing of the septa orad.

A good example (Plate II, Figure 2; Plate III, Figure 6), shows no essential difference from those already described except in the occurrence of the "raised line." The spacing and curvature of the septa are the same and the peculiar siphuncular thickenings and the inorganic deposits on the siphuncular side are identical. It will be observed that the antisiphonal side is so weathered that the external portions of the camerae are lost. A very critical comparison shows a slightly greater relative width for the siphuncular rings and a somewhat more marginal position for the siphuncle. The following measurements indicate the proportions of this specimen:

Length	100 mm.
Width at larger end	32 mm.
Width at smaller end	26 mm.
Contains 20 camerae.	
Length of apicad camera	3.5 mm.
Length of orad camera	6 mm.
Ratio of length to width of camera, orad	1: 5.3

Ratio of length to width of camera, apicad	1: 7.4
Width of siphuncular segment, apicad	3.5 mm.
Ratio of width to length of segment	1:1

(Anteriorly the segments are relatively narrower).

Locality.—Prison quarry, Mimico.
No. 1226 H.R., Royal Ontario Museum of Paleontology.

Actinoceras *cf.* clouei (*Barrande*)

Plate IV, Figure 5.

Orthoceras clouei, *Barrande.* Syst. Sil. du Centre Bohême, ser. 2, 1870, pl. 432, figs. 1-6; pl. 433, figs. 1, 2; pl. 434, figs. 1-5.
Orthoceras clouei, *Barrande.* Syst. Sil. de la Bohême, texte, Vol. 2, Part 3, 1874, p. 718.
Actinoceras clouei, *Parks.* Palaeoz. Foss. Region, S.W. of Hudson Bay, Trans. Royal Can. Inst., 1915, p. 86; pl. 2, fig. 6; pl. 6, fig. 1.

This species was established by Barrande on specimens from Newfoundland. According to his description, the shell is sometimes slightly curved, sometimes straight; the section is nearly circular, but in some instances slightly elliptical. The siphuncle is near one side—in curved forms, the concave side. The apical angle varies from 9° to 16°. The sutures are fairly regular and horizontal, and the spacing of the septa increases with the diameter of the shell, but does not exceed 10 mm. The curvature of the septa is about one-fifth of their greatest diameter. The largest specimen measures 210 mm. in length with a maximum width of almost 80 mm.

The camerae are more or less filled with a deposit which Barrande considers of organic origin. This forms on both sides of the septa; apicad it fills the whole camerae; orad it is less developed leaving an open space in the middle of the camera.

The form of the siphuncular elements is nummuloidal and notably flattened, the width is to the length as 5 to 2. The *anneaux obstructeurs* are strongly developed.

The Toronto collections have yielded a single specimen which is with much hesitation provisionally ascribed to this species. The fragment is 79 mm. long. The antisiphonal side is entirely crushed making it impossible to state the width with certainty, but it was probably 28 mm. wide at the larger and 18 mm. at the smaller end.

In this distance are 19 camerae, making the average length of each nearly 4 mm. The surface appears to be smooth.

A vertical section in the dorso-ventral plane reveals a siphuncle characteristic of the genus *Actinoceras* and strikingly different from that of any other of our specimens. The siphuncular segments are inclined to the axis of the shell on account of the marginal position of the siphuncle: they are distinctly nummuloidal and about 20 mm. wide and 11 mm. long at the larger end. The siphuncle is almost filled with organic deposits, the *anneaux obstructeurs* of Barrande, which are disposed as concentric "rosettes" around the septal necks.

The camerae on the ventral side (right in figure) are almost filled with a deposit of calcite apparently similar to the organic deposits of Barrande. On the antisiphonal side none of this is seen, but, as the shell and septa are entirely destroyed in this region, its absence may be due to imperfection. It seems strange, however, that so solid a structure would entirely disappear on one side and be so perfectly preserved on the other.

In the figure (Plate IV, Figure 5), the eight camerae apicad are shown at the lower end. The section is almost through the centre of the siphuncle apicad;

higher up it is a little to one side. On the right the siphuncular sheaths are apparent, but on the left they are destroyed; on this side also the radiating tubuli are well shown. The septa on the right side are somewhat restored; in the specimen they are undulating and somewhat broken.

This specimen is unique in our collections; it is ascribed to *A. clouei* with great doubt. The resemblance to this form is seen in the character of the siphuncle, its internal thickenings, and its marginal position; also, in the "organic deposits" in the camerae. It differs from *A. clouei* in its smaller size and in the less flattened siphuncular segments.

Locality.—Humbervale quarry.
No. 1228 H.R., Royal Ontario Museum of Paleontology.

VERMES

Order ERRANTIA

Although the jaws of errant annelids are known to occur in considerable abundance at Toronto, only a limited number of specimens appear in our collections. Under such circumstances, we are unable to add any information to the account published in 1879, in the Quarterly Journal of the Geological Society of London, by Dr. G. J. Hinde. It has been thought advisable, therefore, to reproduce Dr. Hinde's entire text with accompanying plates. The only additions are the generic descriptions and the synonymy.

Genus EUNICITES, *Ehlers*

EUNICITES, *Ehlers.* Paleontographica, 17, 1868, p. 147.
EUNICITES, *Zittel.* Handb. Pal., 1, 1880, p. 565.
EUNICITES, *Miller.* N.A. Geol. Pal., 1889, p. 518.
EUNICITES, *Grabau and Shimer.* N.A. Index Fossils, 1910, 2, p. 241.
EUNICITES, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 510.

Grabau and Shimer's description of this genus follows:

Minute, elongate, denticulate jaws with numerous teeth; subquadrate jaws with few teeth; simple, more or less curved, narrow hooks without denticles.

EUNICITES MAJOR, *Hinde*

Plate V, Figure 1.

EUNICITES MAJOR, *Hinde.* Quart. Jour. Geol. Soc. London, 35, 1879, p. 374, pl. 18, fig. 1.
EUNICITES MAJOR, *Grabau and Shimer.* N.A. Index Fossils, 2, 1910, p. 241, fig. 1530a.
OENONITES MAJOR, *Miller.* N.A. Geol. Pal., 1889, p. 519.
EUNICITES MAJOR, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 511.

Hinde describes the species as follows:

Jaw oblong, somewhat flattened, the upper edge curved inwards; the posterior end truncated, with a deep furrow leading to an oval central depression, from which a cavity apparently extends under the front portion of the jaw; the furrow is bounded above and below by rounded ridges. At the front of the jaw are two stout blunted teeth, and the upper edge carries seven or eight short, subequal, rounded teeth.

This is an abundant form, though perfect specimens are rarely met with. It varies greatly in size; the smaller examples are about 1 line long, whilst the largest, as in the specimen figured, are 3½ lines in length and 1⅛ wide. It may be distinguished from *E.* (*Nereidavus*) *varians*, Grinnell, by its truncated extremity and the median furrow and cavity.

EUNICITES (Nereidavus) VARIANS, *Grinnell*

Plate V, Figures 2, 3 and 5.

NEREIDAVUS VARIANS, *Grinnell.* Amer. Jour. Sci., 3rd ser., 14, 1877, p. 230, figs. 1, 2.
NEREIDAVUS VARIANS, *Miller.* N.A. Geol. Pal., 1889, p. 519, fig. 939.
EUNICITES (Nereidavus) VARIANS, *Hinde.* Quart. Jour. Geol. Soc. London, 35, 1879, p. 375, pl. 18, figs. 2, 3, 5.
NEREIDAVUS VARIANS, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 852. (See for full synonymy).

The description by Hinde follows:

Jaw elongated, curved, rounded in front, and convex, widest about one-third the length from the anterior end, and then gradually tapering to a point, the front portion somewhat larger than the rest; succeeding this are from two to five, blunted, rounded, upright teeth, and then a series, varying in different specimens, of from nine to fourteen pointed teeth. These latter gradually diminish in size towards the posterior end, and are uniformly directed backwards. The dimensions of the specimens figured are as follows:—fig. 2, 2 lines long and ½ line wide; fig. 3, 2⅛ lines long and about ¼line in width; fig. 5, 3⅛ lines long and ⅞ line wide. Abundant.

EUNICITES CONTORTUS, *Hinde*

Plate V, Figure 4.

EUNICITES CONTORTUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 375, pl. 18, fig. 4.
EUNICITES CONTORTUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 241, fig. 1530d.
EUNICITES CONTORTUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 510.

Hinde's description follows:

Jaw elongated, very narrow, and tapering to a point, the anterior tooth prominent, nearly upright, not in plane with the rest, and followed by a uniform series of about seventeen pointed teeth, which are all directed backwards, parallel with each other. Length about 1⅛ line.

EUNICITES PERDENTATUS, *Hinde*

Plate V, Figure 6.

EUNICITES PERDENTATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 375, pl. 18, fig. 6.
LUMBRICONEREITES PERDENTATUS, *Miller*. N.A. Geol. Pal., 1889, p. 519. (gen. ref.).
EUNICITES PERDENTATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 511.

Hinde gives the following description:

Jaw extremely small, narrow, and gently curved; the anterior end elevated and bent inwards; on this portion are two or three rounded teeth, which are followed by a series of about twenty very minute, subequal, acutely pointed teeth. Length ⅝ line. Abundant.

EUNICITES SIMPLEX, *Hinde*

Plate VI, Figure 2.

EUNICITES SIMPLEX, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 376, pl. 19, fig. 2.
EUNICITES SIMPLEX, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 511.
EUNICITES SIMPLEX, *Grabau and Shimer*. N.A. Index Fossils. 2, 1910, p. 242, fig. 1528b.

The description by Hinde follows:

Jaw consisting of a simple, slightly curved hook, narrow throughout, and angular in section. Length 1⅛ line.

EUNICITES GRACILIS, *Hinde*

Plate VI, Figure 3.

EUNICITES GRACILIS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 376, pl. 19, fig. 3.
EUNICITES GRACILIS, *Grabau* and *Shimer*. N.A. Index Fossils, 2, 1910, p. 242, fig, 1528c.
EUNICITES GRACILIS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 511.

Hinde's description follows:

Jaw composed of a nearly straight, slightly convex basal portion with a strongly curved anterior hook. Length 1 line, about ¼ line in width.

EUNICITES ? DIGITATUS, *Hinde*

Plate VI, Figure 13.

EUNICITES ? DIGITATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 376, pl. 19, fig. 3.
EUNICITES ? DIGITATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 511.

Hinde describes the species as follows:

Jaw very small, triangular, and nearly equilateral. At one extremity are two slender, elongated, nearly straight teeth, behind which, on the straight upper border, are seven minute rounded teeth. Length of upper edge about ⅜ line.

Genus OENONITES, *Hinde*

OENONITES, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 376.
OENONITES, *Miller*. N.A. Geol. Pal., 1889, p. 519.
OENONITES, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 242, fig. 1532c.
OENONITES, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 868.

Hinde gives the following description of the genus:

Jaws with a more or less curved anterior hook, followed by a series of smaller teeth, similar in character to those of the existing genus *Oenone*.

OENONITES CURVIDENS, *Hinde*

Plate V, Figure 7.

OENONITES CURVIDENS. *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 376, pl. 18, fig. 7.
OENONITES CURVIDENS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 868.

Hinde's description follows.

Jaw nearly straight, with a strongly convex ridge, forming the lower portion of the base; in front a relatively large, very strongly curved tooth, obliquely bent: this is succeeded by fourteen small pointed teeth, carried on a very narrow flattened ridge. Length ¾ line, about ¼ line in width.

OENONITES INAEQUALIS, *Hinde*

Plate V, Figure 8.

OENONITES INAEQUALIS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 376, pl. 18, fig. 8.
OENONITES INAEQUALIS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 869. (See for full bibliography).

Hinde gives the following description:

Jaw nearly straight, tapering to a point; a small projecting appendage below the anterior part of the base, a slightly curved and blunted anterior tooth, succeeded by three minute blunted teeth behind which are six or seven larger acutely pointed teeth. Length 1 line, width rather more than ¼ line.

OENONITES SERRATUS, *Hinde*

Plate V, Figure 9.

OENONITES SERRATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 376, pl. 18, fig. 9.
OENONITES SERRATUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 242, fig. 1526a.
OENONITES SERRATUS. *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 869. (See for full bibliography).

Hinde gives the following description:

Jaw elongated, narrow, the toothed border slightly arched, truncated at the posterior end, which is wider than the front portion of the jaw, and is slightly concave, with a narrow median furrow. The anterior tooth is but slightly curved, behind which are, first in order, four very small rounded teeth, and then a series of twelve very minute pointed teeth. Length ⅝ line.

OENONITES ROSTRATUS, *Hinde*

Plate V, Figure 10.

OENONITES ROSTRATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 376, pl. 18. fig. 10.
OENONITES ROSTRATUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910. p. 242, fig. 1526b.
OENONITES ROSTRATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, p. 869.

The following description is given by Hinde:

Jaw relatively short, very wide and truncate; a deep furrow just below the toothed edge, extending from the middle to the truncated extremity, and below the termination of the furrow is a projecting knob-like elevation; a stout curved tooth in front, behind which are four claw-shaped teeth, followed by five founded teeth. Length ¾ line, width ⅜ line nearly.

OENONITES CUNEATUS, *Hinde*

Plate V, Figure 11.

OENONITES CUNEATUS, *Hinde*, Quart. Jour. Geol. Soc. London, 35, 1879, p. 377, pl. 18, fig. 11.
OENONITES CUNEATUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 242, fig. 1526c.
OENONITES CUNEATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 868.

Hinde describes the species as follows:

Jaw small, compressed, widest in the central portion and tapering gradually to the blunted extremity; a slightly curved anterior tooth, and on the nearly straight upper edge twelve subequal, very minute, rounded teeth. Length ½ line.

OENONITES ? CARINATUS, *Hinde*

Plate VI, Figure 19.

OENONITES ? CARINATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 377, pl. 19, fig. 19.
OENONITES ? CARINATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 868.

The description by Hinde is as follows:

Jaw elongate, truncate posteriorly, the front portion slightly convex; a very stout anterior tooth, and towards the end of the jaw five minute blunted teeth on an angular ridge; the central portion of the jaw beneath the ridge deeply concave. Length ⅝ line.

Genus ARABELLITES, *Hinde*

ARABELLITES, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 377.
ARABELLITES, *Miller*. N.A. Geol. Pal., 1889, p. 517.
ARABELLITES, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910. p. 240.
ARABELLITES, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 57.

Hinde describes the genus as follows:

I propose to include in this genus jaws of widely different form, which have a general resemblance to those of the existing genus *Arabella*, Grube. 1. Jaws with an extremely prominent anterior hook, and a row of smaller teeth on a wide base; 2. Sickle-shaped jaws and allied forms; 3. Jaws subquadrate in form, with a straight upper edge of small teeth. Those of the first division appear to correspond with the first pair, the second resemble the second pair, as figured in Cuvier's 'Regne Animal,' of *Arabella* (*Oenone*) *maculata*, Edwards; whilst the square-shaped jaws I regard as belonging to the lower jaw of Annelids of this genus. Examples of these different forms are very abundant, not only in the Cambro-Silurian, but in all the other formations where the Annelid remains appear.

ARABELLITES HAMATUS, *Hinde*

Plate V, Figure 12.

ARABELLITES HAMATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 377, pl. 18, fig. 12.
ARABELLITES HAMATUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 240, fig. 1526d.
ARABELLITES HAMATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

Hinde's description of the species follows:

Jaw oblong, truncate, the wide base nearly of an even width throughout, a knob-like projection in the centre of the lower basal edge, and a similar one at the end; the anterior tooth relatively wide and openly curved. On the upper straight edge are ten subequal rounded teeth. Length ⅝ line.

ARABELLITES CORNUTUS, *Hinde*

Plate V, Figures 13, 14 and 15.

ARABELLITES CORNUTUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 377, pl. 18, figs. 13-15.
ARABELLITES CORNUTUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 57.

Hinde describes the species:

Jaw relatively wide, truncate, the lower basal edge curved, with a more or less prominent knob-like elevation in the centre, which is the widest part of the base, the upper edge nearly straight, with a deep furrow just below the teeth extending from the middle to the posterior extremity, beneath which a rounded elevation is sometimes present. In front is an extremely large curved hook, and on the nearly straight upper edge is a series of small teeth, from eleven to twenty in number; those towards the front are conical, whilst further back they gradually diminish in size and become rounded. Fig. 13 is one line long and ⅜ line wide; fig. 14 is 1½ line long and ½ line wide; and fig. 15 is 3 lines long and 1 line wide.

ARABELLITES CUSPIDATUS, *Hinde*

Plate V, Figure 19.

ARABELLITES CUSPIDATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 378, pl. 18, fig. 19.
ARABELLITES CUSPIDATUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 241, fig. 1527a.
ARABELLITES CUSPIDATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 57.

Hinde gives the following description of the species:

Jaw oblong, truncate, flattened, with an elongated depression in the upper posterior portion, the lower and upper borders nearly straight and parallel; in front a stout blunted tooth or hook, which is nearly at right angles with the main portion of the jaw, and on the upper edge about eighteen rounded minute teeth. Length 2½ lines, width ¾ line.

ARABELLITES OVALIS, *Hinde*

Plate V, Figure 16.

ARABELLITES OVALIS, *Hinde. Quart.* Jour. Geol. Soc. London, 35, 1879, p. 378, pl. 18, fig. 16.
ARABELLITES OVALIS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

The following description is given by Hinde:

Main portion of jaw of an oval figure, with a very large, curved, and slightly twisted hook in front, and eight or nine small pointed teeth. Total length 1½ line, width ⅜ line.

ARABELLITES GIBBOSUS, *Hinde*

Plate V, Figure 21.

ARABELLITES GIBBOSUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 378, pl. 18, fig. 21.
ARABELLITES GIBBOSUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 241, fig. 1527c.
ARABELLITES GIBBOSUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

The species is described by Hinde as follows:

Jaw oval and strongly convex, with a well-marked curved line extending from the base of the hook to the extremity; in front is a short, slightly curved, very stout hook; on the main portion of the jaw are ten subequal, oblique, pointed teeth. Length 1⅝ line, width ½ line.

ARABELLITES ASCIALIS, *Hinde*

Plate V, Figure 17.

ARABELLITES ASCIALIS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 378, pl. 18, fig. 17.
ARABELLITES ASCIALIS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 57.

Hinde describes the species as follows:

> Jaw narrow, elongated, and tapering to a point; a very long, curved, anterior tooth, not in the same plane with the body of the jaw; on the straight upper edge there are about seven minute acutely pointed teeth. Length 1 line, width 1/6 line.

ARABELLITES RECTUS, *Hinde*

Plate V, Figure 18.

ARABELLITES RECTUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 378, pl. 18, fig. 18.
ARABELLITES RECTUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

Hinde gives the following description of the species:

> Main portion of jaw somewhat triangular, widest in front, and gradually tapering to the blunted extremity; in front a very large and robust hook, with a deep longitudinal furrow near the outer side. Six teeth are visible on the upper edge of the jaw. Length 3½ lines, width ¾ lines.

ARABELLITES LUNATUS, *Hinde*

Plate VI, Figures 4, 5 and 6.

ARABELLITES LUNATUS, *Hinde*. Quar. Jour. Geol. Soc. London, 35, 1879, p. 378, pl. 19, figs. 4-6.
ARABELLITES LUNATUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 241, fig. 1528d.
ARABELLITES LUNATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

The description by Hinde follows:

> Jaw sickle or crescent-shaped, one end pointed, the other extended into a rod-like prolongation, the front surface concave. On the curved outer rim of the crescent are from ten to twelve short rounded teeth, the two anterior ones are generally slightly larger and somewhat divergent from the others; in one instance, however, these anterior teeth are not present. In fig. 4 the length of the toothed portion is 1 line, and of the projection ¾ line; fig. 5 is 1½ line in length; and fig. 6 is ⅞ line.
>
> This is a very abundant form, and shows a good deal of variation in different examples.

ARABELLITES CRISTATUS, *Hinde*

Plate VI, Figure 7.

ARABELLITES CRISTATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 378, pl. 19, fig. 7.
ARABELLITES CRISTATUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 241, fig. 1528g.
EUNICITES CRISTATUS, *Miller*. N.A. Geol. Pal., 1889, p. 518. (gen. ref.).
ARABELLITES CRISTATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1815, p. 57.

The description by Hinde follows:

> Jaw crescentiform, with but a short angular projection, the front edge curved upwards, surface concave; on the upper border are eleven distinct elevated teeth, the first two of which are smaller and not in plane with the others. Length ¾ line.

ARABELLITES CERVICORNIS, *Hinde*

Plate VI, Figures 8 and 12.

ARABELLITES CERVICORNIS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 379, pl. 19, figs. 8, 12.
ARABELLITES CERVICORNIS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 57.

The species is described by Hinde as follows:

> Jaws very variable in form, sometimes crescentiform, with a short angular extension in front, at other times elongated and extended below the middle of the jaw; in front there are from two to three relatively large divergent teeth, followed by a series of from four to seven minute acute teeth. Length ⅝ line.

ARABELLITES PECTINATUS, *Hinde*

Plate VI, Figure 11.

ARABELLITES PECTINATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 379, pl. 19. fig. 11.
ARABELLITES PECTINATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

Hinde describes the species as follows:

Jaw rudely triangular, the front portion rounded, pointed posteriorly, the sides meet below to form a short blunted extension nearly below the centre of the jaw; the upper border slightly arched, and carrying about fifteen small teeth, those in front rounded and upright, the others acute and directed backwards. Length ⅝ line.

ARABELLITES CRENULATUS, *Hinde*

Plate VI, Figure 9.

ARABELLITES CRENULATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 379, pl. 19, fig. 9.
ARABELLITES CRENULATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 57.

The species is described thus by Hinde:

Main portion of jaw nearly straight, flattened, and gradually tapering; in front is a short blunted rod-like extension at right angles to the toothed part of the jaw, which carries eight stout teeth, the first of which is small and claw-shaped, the others triangular and acute. Length ¾ line. Abundant.

ARABELLITES QUADRATUS, *Hinde*

Plate VI, Figure 14.

ARABELLITES QUADRATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 379, pl. 19, fig. 14.
ARABELLITES QUADRATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

Hinde gives the following description of the species:

Jaw composed of a nearly square, slightly convex plate, with a blunted rod-like appendage projecting obliquely from one of the lower angles; on the upper, nearly straight, edge of the plate is a series of about fifteen small, subequal, rounded teeth or crenulations, whilst just below the upper edge, on what appears to be the posterior side, there is a small spur-like tooth projecting obliquely. Length of the toothed edge ¾ line.

ARABELLITES SCUTELLATUS, *Hinde*

Plate VI, Figure 16.

ARABELLITES SCUTELLATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 379, pl. 19, fig. 16.
ARABELLITES SCUTELLATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

The following description is given by Hinde:

Upper portion of the jaw subquadrate, with a prolonged, gradually narrowing base; surface slightly convex, with a very prominent protuberance at the lower posterior angle; the nearly straight upper border carries eleven teeth, of which the first is pointed, somewhat longer than the rest, and projects outwards; the others are subequal rounded teeth. Length and width each about ½ line. Abundant.

ARABELLITES? OBLIQUUS, *Hinde*

Plate VI, Figure 15.

ARABELLITES? OBLIQUUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 379, pl. 19, fig. 15.
ARABELLITES? OBLIQUUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 58.

Hinde describes the species as follows:

Jaw composed of a comparatively thick, obliquely semioval, concave plate; the lower rounded edge is slightly elevated, the straight upper border has about fifteen small rounded subequal teeth or crenulations. Length ⅞ line, width ½ line.

Genus LUMBRICONEREITES, *Ehlers*

LUMBRICONEREITES, *Ehlers*. Palaeontographica, 17, 1868, p. 159.
LUMBRICONEREITES, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 380.
LUMBRICONEREITES, *Zittel*. Handb. Pal., 1, 1880, p. 566.
LUMBRICONEREITES, *Miller*. N.A. Geol. Pal., 1889, p. 518.
LUMBRICONEREITES, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 242.
LUMBRICONEREITES, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 769.

The genus is described by Hinde as follows:

> Ehlers based this genus on the resemblance of some fossil Annelids in the Solenhofen shales to those of the existing genus *Lumbriconereis.* In his specimens only the jaws appear to have been recognizable, whilst my own examples, which I propose to place under this genus, resemble the principal jaw-plate in the upper jaw; but possess a well-defined basal flange or extension.

LUMBRICONEREITES DACTYLODUS, *Hinde*

Plate VI, Figure 20.

LUMBRICONEREITES DACTYLODUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 380, pl. 18, fig. 20.
LUMBRICONEREITES DACTYLODUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 242, fig. 1527b.
LUMBRICONEREITES DACTYLODUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 770.

The species is described by Hinde as follows:

> Jaw oblong, straight, and nearly of uniform width, in the central portion a well-marked protuberance; at the front end are four curved rounded teeth bent upwards and inwards, whilst on a slightly elevated ridge, which springs obliquely from the basal flange, is a series of eighteen small rounded teeth. Length nearly 2½ lines, width ¾ line.

Genus GLYCERITES, *Hinde*

GLYCERITES, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 380.
GLYCERITES, *Miller*. N.A. Geol. Pal., 1889, p. 518.
GLYCERITES, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 243.
GLYCERITES, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 552.

The genus is described by Hinde as follows:

> Jaws consisting of a simple curved hook with a side base, without smaller teeth, resembling those of the existing genus *Glycera*.

GLYCERITES SULCATUS, *Hinde*

Plate VI, Figure 1.

GLYCERITES SULCATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 380, pl. 19, fig. 1.
GLYCERITES SULCATUS, *Grabau and Shimer*. N.A. Index Fossils, 2, 1910, p. 243, fig. 1528a.
GLYCERITES SULCATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 552.

Hinde's description follows:

> Jaw oblong, relatively wide and convex, obliquely truncate; from the truncated end a deep longitudinal furrow extends nearly to the front, where it opens into a cavity which extends below the hook; this is stout, slightly curved and somewhat bent inwards; Length 1¼ line, nearly ½ line in width.

GLYCERITES SULCATUS EXCAVATUS, *Hinde*

Plate VI, Figure 10.

GLYCERITES SULCATUS, *var.* EXCAVATUS, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 380, pl. 19, fig. 10.
GLYCERITES SULCATUS EXCAVATUS, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 552.

The variety is described by Hinde as follows:

> The hooked portion in this jaw closely resembles that just described, but the posterior end is relatively wider and hollowed out, and instead of the central furrow there is a deep groove which extends round the inner edge of the main portion of the jaw. Length 1 line, width ½ line.

APPENDIX TO ERRANTIA – CONODONTS

Certain minute denticles, known as *Conodonts*, are met with in the rocks at Toronto. They are frequently referred to as the teeth of Cyclostomes, but their affinities are quite uncertain. For convenience, therefore, we have placed them as an appendix to the *Errantia*.

Genus DREPANODUS, *Pander*

Drepanodus, *Pander.* Mon. d. foss. Fische Sil. Syst., 1856, p. 20.
Drepanodus, *Miller.* N.A, Geol. Pal., 1889, p. 518.
Drepanodus, *Grabau and Shimer.* N.A. Index Fossils, 2, 1910, p. 245.
Drepanodus, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 463.

Grabau and Shimer describe the genus as follows:

Single, straight or curved teeth of more or less circular or elliptical section.

Drepanodus arcuatus, *Pander*

Plate VI, Figures 21 and 22.

Drepanodus arcuatus, *Pander.* Mon. foss. Fish. Sil. Syst., 1856, p. 20, tab. 1, figs. 2, 4, 5.
Drepanodus arcuatus, *Hinde.* Quart. Jour. Geol. Soc. London, 35, 1879, p. 357, pl. 15, figs. 7, 8.
Drepanodus arcuatus, *Grabau and Shimer.* N.A. Index Fossils, 2, 1910, p. 245, fig. 1537, d, e.
Drepanodus arcuatus, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 463.

Hinde gives the following specific description:

Tooth simple, resembling a more or less curved spine, nearly circular in section, the basal portion expanded and with a slight contraction between it and the shaft of the tooth. The teeth are all translucent and of a reddish horn-color; they vary in length from ¾ line to 1⅛ line, and in width at the base from ¼ line to ⅜ line.

Genus DISTACODUS, *Hinde*

Machairodus, *Pander.* Mon. Foss. Fische Sil. Syst., 1856, p. 23.
Distacodus, *Hinde.* Quart. Jour. Geol. Soc. London, 35, 1879, p. 357.
Distacodus, *Miller.* N.A. Geol. Pal., 1889, p. 518.
Distacodus, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 460.

Distacodus incurvus, (*Pander*)

Plate VI, Figure 23.

Machairodus incurvus, *Pander.* Mon. Foss. Fische Sil. Syst., 1856, p. 23, tab. 1, fig. 22.
Distacodus incurvus, *Hinde.* Quart. Jour. Geol. Soc. London, 35, 1879, p. 357, pl. 15, fig. 9.
Distacodus incurvus, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 460.

Hinde describes the species as follows:

Base of tooth expanded, the shaft slightly curved, the point compressed and acute; a very strongly marked broad and sharp edge on the outer curve, and a similarly sharp, but narrower edge on the inner curve of the tooth; the central portion convex in section. Length 1¼ line, width of base ½ line.

Genus PRIONIODUS, *Pander*

Prioniodus, *Pander.* Mon. d. foss. Fische Sil. Syst., 1856, p. 28.
Prioniodus, *Miller.* N.A. Geol. Pal., 1889, p. 520.
Prioniodus, *Grabau.* Bull. Buffalo Soc. Nat. Sci., 6, 1889, p. 150.
Prioniodus, *Grabau and Shimer.* N.A. Index Fossils, 2, 1910, p. 244.
Prioniodus, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 1034.

The following generic description is given by Grabau and Shimer:

Jaw with narrow basal portion, supporting numerous delicate denticles, and an elongated tapering tooth which extends below the basal portion.

Prioniodus elegans, *Pander*

Plate VI, Figure 24.

Prioniodus elegans, *Pander.* Mon. Foss. Fische Sil. Syst., 1856, p. 29, pl. 2, figs. 22, 23.
Prioniodus elegans, *Hinde.* Quart. Jour. Geol. Soc. London, 35, 1879, p. 358, pl. 15, fig. 10.
Prioniodus elegans, *Grabau and Shimer.* N.A. Index Fossils, 2, 1910, p. 244, fig. 1538d.
Prioniodus elegans, *Bassler.* U.S. Nat. Mus., Bull. 92, 1915, p. 1034.

Hinde's description of this species follows:

Basal portion straight and narrow; at the anterior extremity is an elongated tapering main tooth, the lower portion of which appears to extend below the front part of the base. On the base are thirteen straight, delicate, pointed denticles nearly uniform in size. Both main tooth and denticles convex in section. Length of main tooth ⅝ line, of the horizontal base ⅝ line.

Prioniodus? politus, *Hinde*

Plate VI, Figures 26 and 27.

Prioniodus? politus, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 358, pl. 15, fig. 13.
Prioniodus? politus, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1034.

The following description is given by Hinde:

Basal portion of tooth compressed, uneven in width, straight or slightly curved; at or near the central part a short robust main tooth with a series of short compressed denticles, varying from five to eight in number, on either side of it. Length of base from ½ line to ¾ line. The specimens have a bright polished appearance and a light horny tint.

Prioniodus furcatus, *Hinde*

Plate VI, Figure 25.

Prioniodus furcatus, *Hinde*. Quart. Jour. Geol. Soc. London, 35, 1879, p. 358, pl. 15, fig. 13.
Prioniodus furcatus, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 1034.

Hinde gives the following specific description:

Base narrow and strongly arched, at the centre of the arch a prominent robust main tooth, slightly curved, depressed convex, and with sharp edges, the lower extremity blunted and produced beyond the base. On one side of the central tooth the base carries six flattened denticles inclined to the centre; on the other side are eight similar denticles, but vertical to the base. Length of main tooth ⅜ line; distance between the extremities of the base ⅝ line.

Order TUBICOLA

Genus CORNULITES, *Schlotheim*

Cornulites, *Hall*. Pal. New York, 5, pa. 2, 1879, p. 164.
Cornulites, *Schlotheim*. Petrefaktenkund, 1820, p. 378.
Cornulites, *Zittel and Eastman*. Textb. Pal., 2nd Ed., 1913, p. 139.
Cornulites, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 277. (*See* for full bibliography).

The definition of this genus as given by Zittel (*op. cit.*) follows:

Thick-walled, trumpet-shaped tubes, closed at the lower end, and sometimes attaining a length of three or four inches. Exterior annulated, and covered with very fine longitudinal striae.

Cornulites *cf.* sterlingensis (*Meek and Worthen*)

Plate II, Figures 5 and 6.

Tentaculites sterlingensis, *Meek and Worthen*. Geol. Surv. Illinois, 3, 1868, p. 343, pl. 4, fig. 8.
Tentaculites sterlingensis, *Hall*. Pal. New York, 7, Sup., 1888, p. 17, pl. 115, figs. 5-7, 32.
Tentaculites sterlingensis, *Bassler*. U.S. Nat. Mus., Bull. 92, 1915, p. 280.

The description by Meek and Worthen follows:

Shell small, slightly arched, and gradually tapering to a point; section circular; annulations prominent, angular, rising abruptly from the surface, usually about their own breadth apart; constrictions between the annulations, with fine, sharply elevated, longitudinal striae, which are not continued upon the rings.

Length, 0.56 inch; breadth at the larger end, 0.08 inch; annulations five in the space of one-eighth of an inch, at the larger end, and nine or ten in the same space at the smaller end. Longitudinal striae, five in the space of 0.02 inch.

Our rocks contain a single species of *Cornulites,* the determination of which is attended with some difficulties. The form has been referred to *C. flexuosus, C. tenuistriatus,* and *C. sterlingensis.*

Our specimens are straight or slightly curved and as far as observed do not exceed 9.5 mm. in length. Specimens of this size vary from 1.5 to 2.5 mm. in diameter at the larger end. In this total length are about 26 annulations, nearer together at the small end (.2 mm.) and more widely spaced at the larger end (.3 mm.). These annulations are rather sharp and are separated by regularly concave depressions. Fine longitudinal lines traverse the depressions, but do not seem to pass over the summits of the annulations.

Cornulites flexuosus was described by Hall from strata of Trenton age. His description and figures indicate a rather curved form with more strongly curved tip, increasing rather rapidly in diameter, and with the longitudinal striae continuous over the annulations. Later Hall ascribed to the same species a form found in the Lockport limestone: this is evidently not a member of the genus, a fact which has been recognized by many later authorities. *C. flexuosus* is recognized by Cumings from the upper part of the Utica in Indiana. His figure indicates a form 60 mm. long and 20 mm. wide at the large end.

The annulations are sharp with concave intervals and occur at the middle of the drawing at intervals of about .5 mm. The longitudinal striae seem to be continuous over the annulations. Cumings further remarks that this form is probably identical with *C. conicus,* Nicholson. Bassler, however, lists *C. conicus* as a distinct species. A comparison of our form with the figures of *C. conicus* given in the supplement to Vol. V, Pt. 2 of the Paleontology of New York, leaves no doubt as to the distinctness of the two forms.

Compared with Hall's original figures or with that given by Cumings, it is at once apparent that our form is very much finer in the annulations and differs also in that the longitudinal striae do not pass over the annulations. Our shells are also much more gradually tapering.

Cornulites tenuistriatus has been listed as occurring in the rocks at Toronto, but it does not seem possible to ascribe to that species any specimens in the museum. *C. tenuistriatus* is a much larger form with the annulations near the aperture 2.5 mm. apart. This spacing is so much greater than in our specimens that it is difficult to believe that Nicholson could have mistaken such specimens as ours for *C. tenuistriatus.*

Our specimens approach most closely to *Cornulites sterlingensis* which they resemble in size, in spacing of the annulations and of the longitudinal striae. The figure given by Meek and Worthen seems to show that the annulations are more rounded than in the Toronto forms but the figures given by Hall in the Supplement to Vol. V of the Paleontology of New York agree almost exactly. *C. sterlingensis* has hitherto been regarded as a Richmond fossil; if the Toronto form is identical the range of the species is greatly extended for it occurs practically through the whole series at Toronto and is also common in the Workman Brook section of the Lorraine at Meaford.

Locality.—Near water level, Humber river, ½ mile below Weston.
No. 1214 H.R., Royal Ontario Museum of Paleontology.

INDEX, PART IX

PAGE

Acmeidæ 2
Actinoceratidæ 19
Actinoceras 19
Actinoceras crebriseptum 20
Actinoceras *cf.* clouei 27
Arabellites 31
Arabellites ascialis 32
Arabellites cervicornis 33
Arabellites cornutus 32
Arabellites crenulatus 34
Arabellites cristatus 33
Arabellites cuspidatus 32
Arabellites gibbosus 32
Arabellites hamatus 31
Arabellites lunatus 33
Arabellites obliquus 34
Arabellites ovalis 32
Arabellites pectinatus 33
Arabellites quadratus 34
Arabellites rectus 33
Arabellites scutellatus 34
Archinacella 2
Archinacella patelliformis 2
Archinacella pulaskiensis 2
Aspidobranchia 2
Bactrites gracilis 22
Bactrites subconicus 22
Bellerophon 4
Cameroceras 14
Cephalopoda 2, 14
Clathrospira 5
Clathrospira subconica 5
Conodonts 35
Conularia 13
Conularia formosa 13
Conulariida 13
Conulariidæ 13
Cornulites 37
Cornulites *cf.* sterlingensis 37, 38
Cyclonema 11
Cyclonema bilix 11
Cyclonema *sp. indet.* 12
Cyrtolites 3
Cyrtolites ornatus 3
Cyrtolitidæ 3
Distacodus 36
Distacodus incurvus 36
Drepanodus 36
Drepanodus arcuatus 36
Endoceras 14
Endoceras proteiforme 14, 15
Endoceratidæ 14
Eotomaria 5
Errantia 28
Eunicites 28
Eunicites contortus 29
Eunicites (?) digitatus 29
Eunicites gracilis 29

PAGE

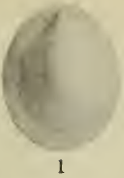
Eunicites major 28
Eunicites perdentatus 29
Eunicites simplex 29
Eunicites varians 28
Gastropoda 2
Glycerites 35
Glycerites sulcatus 35
Glycerites slucatus excavatus 35
Holochoanites 14
Hormotoma 6
Hormotoma gracilis 6
Liospira 7
Liospira helena 7
Liospira progne 7
Liospira vitruvia 7
Lophospira 8
Lophospira beatrice 8
Lophospira beatrice parva 10
Lophospira bowdeni 9
Lophospira multigruma 11
Lophospira perangulata 9
Lophospira tropidophora 10
Lumbriconereites 34
Lumbriconereites dactylodus 35
Mullusca 2
Murchisonia 6, 8
Nautiloidea 14
Nereidavus 28
Oenonites 30
Oenonites (?) carinatus 31
Oenonites cuneatus 31
Oenonites curvidens 30
Oenonites inæqualis 30
Oenonites rostratus 30
Oenonites serratus 30
Orthoceras 16
Orthoceras duseri 16
Orthoceras lamellosum 18
Orthoceras mohri 23
Orthoceratidæ 16
Palæschara beani 17
Pleurotomariidæ 5
Pleurotomaria 7, 8
Prioniodus 36
Prioniodus elegans 36
Prioniodus furcatus 37
Prioniodus (?) politus 37
Protowarthia 4
Raphistoma 7
Sinuites 4
Sinuites cancellatus 5
Sinuitidæ 4
Trochonema 12
Trochonema umbillicatum 12
Trochonematidæ 11
Tubicola 37
Vermes 2, 28

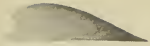
EXPLANATION OF PLATE I

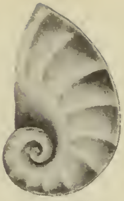
Unless otherwise indicated, figures are of natural size.

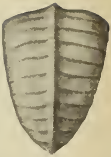
Fossil	Number	Locality	Page
Fig. 1. *Archinacella pulaskiensis* × 1.5	1211 H.R.	Don brickyard	2
Fig. 2. *Archinacella pulaskiensis* × 1.5	1211 H.R.	Don brickyard	2
Fig. 3. *Cyrtolites ornatus*	1208 H.R.	Humbervale quarry	3
Fig. 4. *Cyrtolites ornatus*	1209 H.R.	Don brickyard	3
Fig. 5. *Cyrtolites ornatus* × 10	1209 H.R.	“ “	3
Fig. 6. *Sinuites cancellatus*	After Ulrich and Scofield	....	5
Fig. 7. *Sinuites cancellatus*	“ “	....	5
Fig. 8. *Sinuites cancellatus*	“ “	....	5
Fig. 9. *Clathrospira subconica*	292 T.	Toronto drift	5
Fig. 10. *Hormotoma gracilis*	1213 H.R.	Don brickyard	6
Fig. 11. *Liospira helena*	1202 H.R.	Etobicoke river	7
Fig. 12. *Liospira helena*	After Billings		7
Fig. 13. *Lophospira beatrice*	1197 H.R.	Humber river	8
Fig. 14. *Lophospira beatrice parva*	1199 H.R.	Don brickyard	10
Fig. 15. *Lophospira tropidophora*	1206 H.R.	Humbervale quarry	10
Fig. 16. *Lophospira tropidophora*	1236 H.R.	Humbervale quarry	10
Fig. 17. *Cyclonema bilix*	1212 H.R.	Weston	11
Fig. 18. *Cyclonema sp. indet*	1218 H.R.	Don brickyard	12
Fig. 19. *Trochonema umbillicatum*	After Ulrich and Scofield	....	12

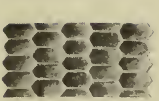
Plate I

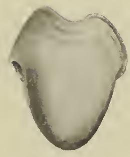

1

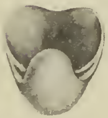

2

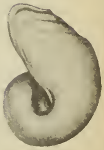

3

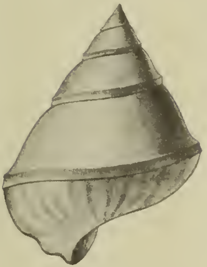

4


5

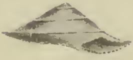

6

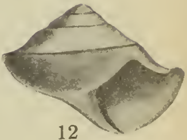

7

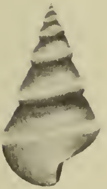

8

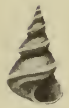

9

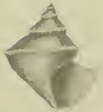
10

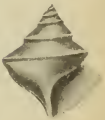

11

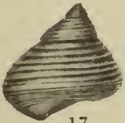

12

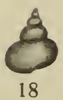

13


14


15


16


17


18

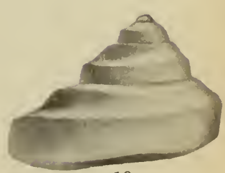
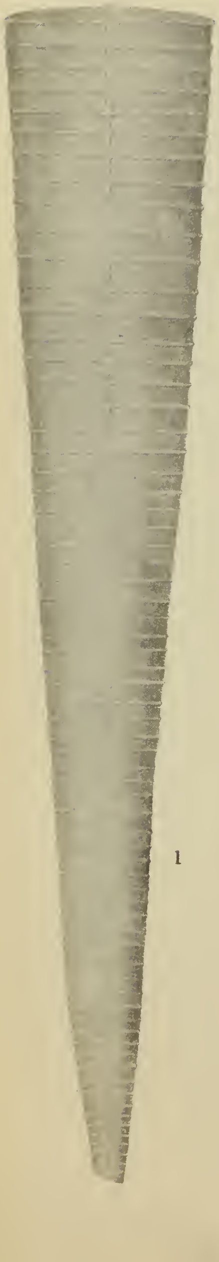
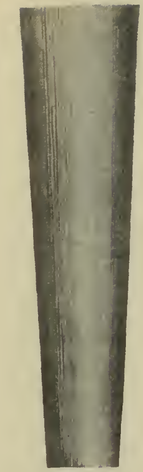

19

Plate II

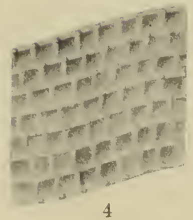


1

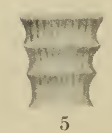
2



3



4



5

6

7

EXPLANATION OF PLATE II

Unless otherwise indicated, figures are of natural size.

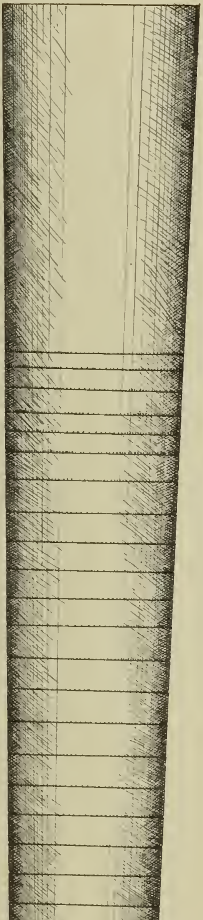
	FOSSIL	NUMBER	LOCALITY	PAGE
Fig. 1.	*Orthoceras duseri*	After Hall and Whitfield	....	16
Fig. 2.	*Actinoceras crebriseptum*	1226 H.R.	Prison Farm quarry	20
Fig. 3.	*Actinoceras crebriseptum*	1225 H.R.	Prison Farm quarry	20
Fig. 4.	*Conularia formosa* × 10	1216 H.R.	Don brickyard	13
Fig. 5.	*Cornulites cf. sterlingensis* × 10	1214 H.R.	Weston	37
Fig. 6.	*Cornulites cf. sterlingensis* × 10	1214 H.R.	"	37
Fig. 7.	*Conularia formosa*	After Miller and Dyer	....	13

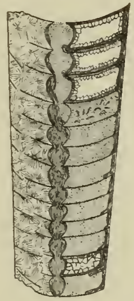
EXPLANATION OF PLATE III

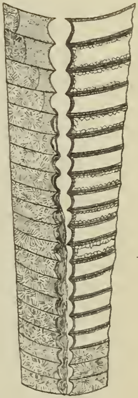
All figures are of natural size.

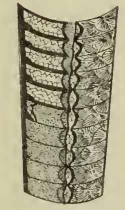
Fossil	Number	Locality	Page
Fig. 1. *Actineroceras crebriseptum.* Specimen showing body chamber	941 H.R.	Humber river	26
Fig. 2. *Actinoceras crebriseptum.* Shows siphuncular thickenings, clay filling (dotted), fibrous layer, secondary calcite with disrupted septa on left, open camerae with later calcite on right, also the continuation of the secondary calcite as a thin layer on right	1219 H.R.	Prison Farm quarry	24
Fig. 3. *Actinoceras crebriseptum.* Similar to Fig. 2 but the antisiphonal side is weathered and consequently the secondary calcite layer and the fibrous layer are absent	1221 H.R.	" "	26
Fig. 4. *Actinoceras crebriseptum.* Similar to Fig. 2 but shows cavity within siphuncular thickenings	1225 H.R.	" "	23
Fig. 5. *Actinoceras crebriseptum.* Transverse section showing the secondary calcite on both walls, also trace of endosiphuncle. It also shows well the formation of the fibrous layer only where clay has not filled the space	1220 H.R.	" "	20
Fig. 6. *Actinoceras crebriseptum.* Dorso-ventral section showing well the formation of the fibrous layer which occurs over all exposed surfaces, clay as well as shell. The antisiphonal side is worn away	1226 H.R.	" "	27
Fig. 7. *Actinoceras crebriseptum.* Transverse section showing the symmetrical way the secondary calcite occurs on the outer walls on the camerae and on the orad side of septa. No siphuncular thickenings. Secondary calcite, dotted; clay, crosses; fibrous layer, crosslined	1229 H.R.	" "	20
Fig. 7a. *Actinoceras crebriseptum.* Dorso-ventral section of siphonal side showing the secondary calcite. Clay, crosses	1229 H.R.	" "	24
Fig. 8. *Actinoceras crebriseptum.* Transverse section showing the secondary calcite on both walls and trace of endosiphuncle	1230 H.R.	Humber river	23
Fig. 9. *Actinoceras crebriseptum.* Dorso-ventral section of large fragment, probably far orad. Shows marginal siphuncle and absence of secondary calcite or siphuncular thickenings	1222 H.R.	Prison Farm quarry	26

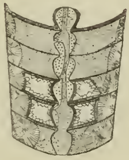
Plate III

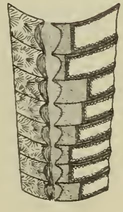

1

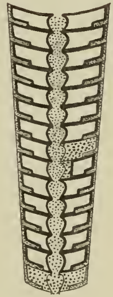

2

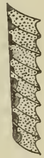

3

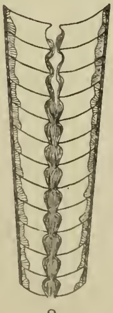

4


5


6


7


7a


8

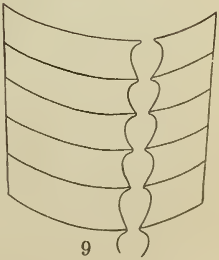
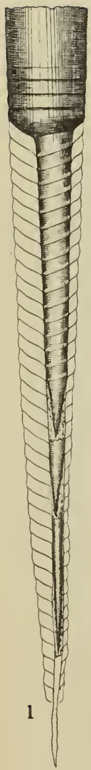
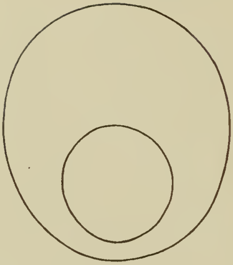

9

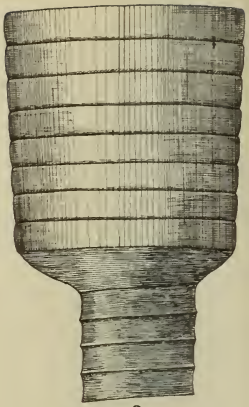
Plate IV



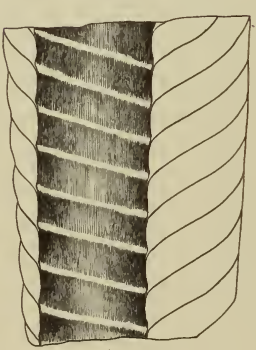
1



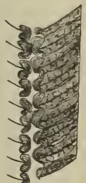
2



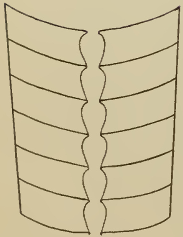
3



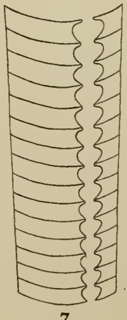
4



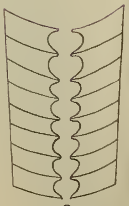
5



6



7



8

EXPLANATION OF PLATE IV

Unless otherwise stated, all figures are of natural size.

	FOSSIL	NUMBER	LOCALITY	PAGE
Fig. 1.	*Endoceras proteiforme.* 1-12 natural size. Portion of body chamber and three camerae orad. Remaining camerae shown in dorso-ventral section. Siphuncle intact orad but broken in places exposing the endocones	1234 H.R.	Nottawasaga	15
Fig. 2.	*Endoceras proteiforme.* One-fourth natural size. Cross section showing size and position of siphuncle	952 H.R.	Collingwood	15
Fig. 3.	*Endoceras proteiforme.* One-half natural size. Average Toronto specimen	1235 H.R.	Humber river	15
Fig. 4.	*Endoceras proteiforme.* One-fourth natural size. Shows overlapping of funnels. Siphuncle intact; camerae in section	952 H.R.	Collingwood	15
Fig. 5.	*Actinoceras cf. clouei.* Vertical section.	1228 H.R.	Humbervale quarry	27
Fig. 6.	*Orthoceras lamellosum.* Transverse vertical section	1233 H.R.	Prison Farm quarry	18
Fig. 7.	*Orthoceras duseri.* Dorso-ventral longitudinal section	12093	Clarksville, Ohio	17
Fig. 8.	*Orthoceras duseri.* Transverse longitudinal section	1223 H.R.	Humber river	18

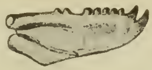
EXPLANATION OF PLATE V

Magnification of figures indicated on plate.

	Fossil	Origin	Locality	Page
Fig. 1.	*Eunicites major*	After Hinde	Toronto	28
Fig. 2.	*Eunicites varians*	" "	"	28
Fig. 3.	*Eunicites varians*	" "	"	28
Fig. 4.	*Eunicites contortus*	" "	"	29
Fig. 5.	*Eunicites varians*	" "	"	28
Fig. 6.	*Eunicites perdentatus*	" "	"	29
Fig. 7.	*Oenonites curvidens*	" "	"	30
Fig. 8.	*Oenonites inaequalis*	" "	"	30
Fig. 9.	*Oenonites serratus*	" "	"	30
Fig. 10.	*Oenonites rostratus*	" "	"	30
Fig. 11.	*Oenonites cuneatus*	" "	"	31
Fig. 12.	*Arabellites hamatus*	" "	"	31
Fig. 13.	*Arabellites cornutus*	" "	"	32
Fig. 14.	*Arabellites cornutus*	" "	"	32
Fig. 15.	*Arabellites cornutus*	" "	"	32
Fig. 16.	*Arabellites ovalis*	" "	"	32
Fig. 17.	*Arabellites ascialis*	" "	"	32
Fig. 18.	*Arabellites rectus*	" "	"	33
Fig. 19.	*Arabellites cuspidatus*	" "	"	32
Fig. 20.	*Lumbriconereites dactylodus*	" "	"	35
Fig. 21.	*Arabellites gibbosus*	" "	"	32

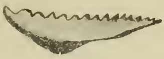
Plate V

1



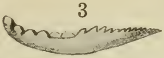
×3

2



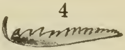
×6

3



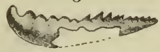
×6

4



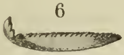
×8

5



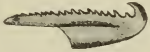
×3½

6



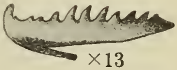
×15

7



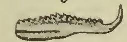
×15

8



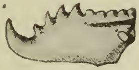
×13

9



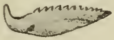
×12

10



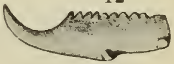
×15

11



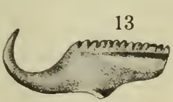
×16

12



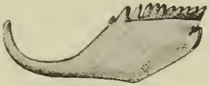
×20

13



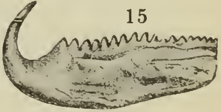
×12

14



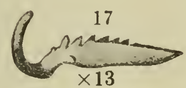
×10

15



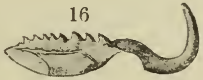
×5

17



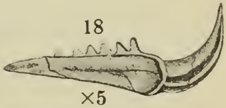
×13

16



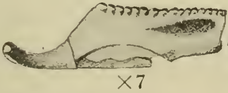
×10

18



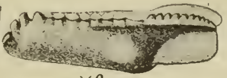
×5

19



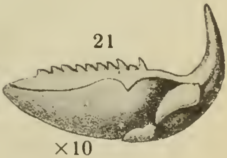
×7

20



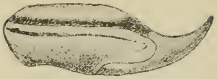
×6

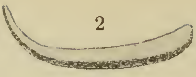
21

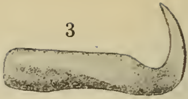


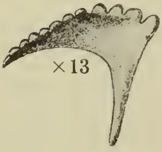
×10

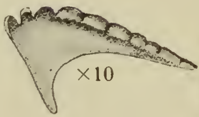
Plate VI

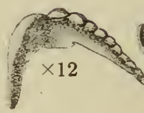
1

×13

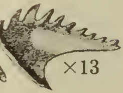
2

×13

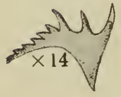
3

×14

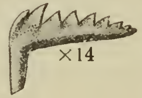
4

×13

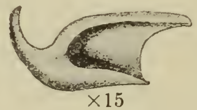
5

×10

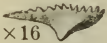
6

×12

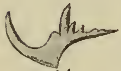
7

×13

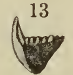
8

×14

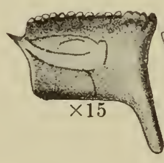
9

×14

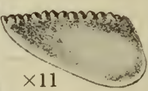
10

×15

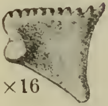
11

×16

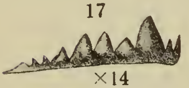
12

×14

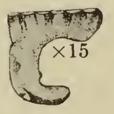
13

×12

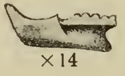
14

×15

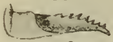
15

×11

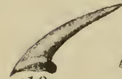
16

×16

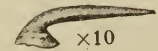
17

×14

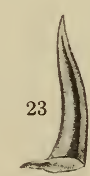
20

×15

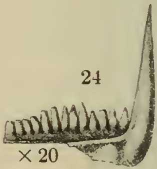
19

×14

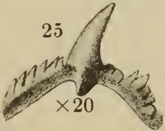
18

×12

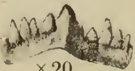
21

×10

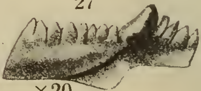
22

×10

23

×10

24

×20

25

×20

26

×20

27

×20

EXPLANATION OF PLATE VI

Magnification of figures indicated on plate.

	FOSSIL	ORIGIN	LOCALITY	PAGE
Fig. 1.	*Glycerites sulcatus*	After Hinde	Toronto	35
Fig. 2.	*Eunicites simplex*	" "	"	29
Fig. 3.	*Eunicites gracilis*	" "	"	29
Fig. 4.	*Arabellites lunatus*	" "	"	33
Fig. 5.	*Arabellites lunatus*	" "	"	33
Fig. 6.	*Arabellites lunatus*	" "	"	33
Fig. 7.	*Arabellites cristatus*	" "	"	33
Fig. 8.	*Arabellites cervicornis*	" "	"	33
Fig. 9.	*Arabellites crenulatus*	" "	"	34
Fig. 10.	*Glycerites sulcatus excavatus*	" "	"	35
Fig. 11.	*Arabellites pectinatus*	" "	"	33
Fig. 12.	*Arabellites cervicornis*	" "	"	33
Fig. 13.	*Eunicites* (?) *digitatus*	" "	"	29
Fig. 14.	*Arabellites quadratus*	" "	"	34
Fig. 15.	*Arabellites* (?) *obliquus*	" "	"	34
Fig. 16.	*Arabellites scutellatus*	" "	"	34
Fig. 17.	*Sp. indet*	" "	"	
Fig. 18.	*Sp. indet*	" "	"	
Fig. 19.	*Oenonites* (?) *carinatus*	" "	"	31
Fig. 20.	*Sp. indet*	" "	"	
Fig. 21.	*Drepanodus arcuatus*	" "	Garrison Common	36
Fig. 22.	*Drepanodus arcuatus*	" "	" "	36
Fig. 23.	*Distacodus incurvus*	" "	" "	36
Fig. 24.	*Prioniodus elegans*	" "	" "	36
Fig. 25.	*Prioniodus* (?) *politus*	" "	" "	37
Fig. 26.	*Prioniodus* (?) *politus*	" "	" "	37
Fig. 27.	*Prioniodus furcatus*	" "	" "	37

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

HON. H. MILLS, MINISTER OF MINES — THOS. W. GIBSON, DEPUTY MINISTER

THIRTY-FIRST ANNUAL REPORT

OF THE

ONTARIO DEPARTMENT OF MINES

BEING

VOL. XXXI, PART X, 1922.

CONTENTS

PAGES
Mining Accidents in Ontario, 1921 .... 1—10
Mines of Ontario .... 11—86
Instruction Classes for Prospectors .... 87—94
Notes on Clays of the Missinaibi River .... 95—96

PRINTED BY ORDER OF THE LEGISLATIVE ASSEMBLY OF ONTARIO

TORONTO
Printed by CLARKSON W. JAMES, Printer to the King's Most Excellent Majesty
1923

Printed by
THE RYERSON PRESS

CONTENTS, PART X

MINING ACCIDENTS IN ONTARIO, 1921.

PAGE

- Accidents during 1921 1
- Workmen's Compensation Rates 1
- Table of Fatalities 2
- Analysis of Fatalities at Mines 2
- Table of Fatal Accidents in Mines, Metallurgical Works and Quarries, 1901 to 1921 3
- Fatalities classified according to occupation and nationality 3
- Table of Fatal Accidents in or about Mines of Ontario during 1921 4
- Table of Fatal Accidents at Metallurgical Works, 1921 4
- Table of Fatal Accidents at Quarries, Clay and Gravel Pits, 1921 4
- Fatalities at mines classified according to cause and place 6
- Non-fatal Accidents Classified according to Occupation and Nationality of Men Injured (Mines) 6
- Causes of Non-fatal Accidents (Mines) 7
- Causes of Non-Fatal Accidents (Metallurgical Works) 7
- Occupation and Nationality of Men Injured (Metallurgical Works) 8
- Occupation and Nationality of Men Injured (Quarries, Clay and Gravel Pits) 8
- Causes of Non-fatal Accidents (Quarries, Clay and Gravel Pits) 9
- Classification of Explosive Accidents 9
- Prosecutions 9
- Testing Hoisting Cables 9

MINES OF ONTARIO.

- Mines and Prospects Inspected, 1921 11
- Metallurgical Works Inspected, 1921 15

- I.—NORTHWESTERN ONTARIO 15
  - Gold 15
  - Iron 17
  - Iron Pyrites 18
  - Silver 18

- II.—SUDBURY, NORTH SHORE AND MICHIPICOTEN 20
  - Gold 20
  - Iron 21
  - Copper 22
  - Nickel and Copper 23
    - British America Nickel Corporation, Limited 24
    - International Nickel Company of Canada, Limited 24
    - Mond Nickel Company, Limited 27
  - Iron Pyrites 28
  - Miscellaneous 28

- III.—DISTRICT OF TIMISKAMING 28
  - Gold 28
    - Boston Creek, Larder Lake, etc. 28
    - Porcupine 31
    - Kirkland Lake 40
    - Matachewan 45
    - West Shiningtree 45
    - Howry Creek 46
  - Silver 47
    - Cobalt 47
    - South Lorrain 55
    - Elk Lake and Gowganda 57

- IV.—SOUTHERN AND EASTERN ONTARIO 58
  - Calcite and Dolomite 58
  - Corundum 59
  - Feldspar 59
  - Fluorspar 63
  - Gold 63
  - Graphite 64
  - Gypsum 64
  - Iron Pyrites 65
  - Lead 65
  - Mica 66
  - Molybdenite 66
  - Talc 67
  - Metallurgical Works 67

- Quarries and Other Excavations 70
  - Quarries Inspected during 1921 71
  - Clay Pits Inspected during 1921 78
  - Sand and Gravel Pits Inspected during 1921 80

INSTRUCTION CLASSES FOR PROSPECTORS.

- Introduction 87
- Methods Adopted 87
- Attendance at Classes 88
  - Madoc 89
  - Sault Ste. Marie 89
  - Port Arthur 89
  - Fort William 90
  - Sudbury 90
  - Haileybury 91
  - Swastika 91
  - Kirkland Lake 92
  - South Porcupine 92
  - Timmins 92
  - Elk Lake 93
  - North Bay 93
- General 93
- Suggestions 94

NOTES ON THE CLAYS OF THE MISSINAIBI RIVER.

- Introduction 95
- Mesozoic Clays 95

DIAGRAM AND ILLUSTRATION

- Silver Islet Mine, Diamond-drilling at the Fourth Level 19
- Mill at Keeley Silver Mine, 1921 56

MINING ACCIDENTS IN ONTARIO, 1921

By

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, G. E. Cole, Ottawa; James Bartlett, Sudbury; J. G. McMillan, Cobalt; A. R. Webster, Toronto.

Accidents during 1921

	Fatal	Non-fatal	Total
Mines, underground	11	597	608
Mines, surface	1	246	247
Metallurgical Works	4	211	215
Quarries	5	...	....
Clay Pits	0	208	216
Sand and Gravel Pits	3	...	....
Total	24	1,262	1,286

During the year 1921, at the mines, metallurgical works, quarries, clay, sand and gravel pits regulated by the Mining Act of Ontario, there were 1,286 accidents reported to the Department of Mines up to January 10, 1922. Twenty-four of these accidents were fatal.

Four of the fatal accidents at quarries occurred in the handling of explosives and were due to carelessness or ignorance; of the three fatal accidents at gravel pits, two were caused by undermining and the third by material falling from a face sixteen feet in height. A knowledge of explosives and a strict observance of the Mining Amendment Act would have prevented all these accidents.

Workmen's Compensation Rates

The assessment per $100 of pay roll made by the Workmen's Compensation Board is based on the actual cost of the accidents occurring in each class during the previous year and consequently shows the accident hazard of each class. The adjusted rates for 1920 and the provisional rates for 1921 show a decrease in the silver mining industry, a slight increase in gold and nickel-copper mining, and a fifty per cent. increase in quarrying. The rate for quarries is twice that of nickel-copper mining, and three times that of silver mining. Most of the employees in quarries are English-speaking, but are unskilled in handling tools and material, have no knowledge of explosives and seldom are under skilled supervision such as prevails at mines. The Department of Mines now has an inspector who devotes all his time to the inspection of quarries, clay, sand and gravel pits in an effort to cut down the unnecessary accident hazard of this industry.

Following is a table of Workmen's Compensation rates:—

	1920 Adjusted.	1921 Provisional.
Silver mining	$2 00	$2 00
Treatment of ores, with heat, in a silver mining industry	1 00	1 00
Treatment of ores, without heat, in a silver mining industry	50	50
Gold mining	2 40	2 50
Treatment of ores, with heat, in a gold mining industry	1 20	1 25

Treatment of ores, without heat, in a gold mining industry	60	70
Nickel or nickel copper mining	3 00	3 00
Treatment of ores, with heat, in a nickel or nickel-copper mining industry	1 50	1 50
Treatment of ores, without heat, in a nickel or nickel-copper mining industry	75	75
Mining N.O.S.	2 50	2 50
Treatment of ores or minerals, with heat, in an industry in this group	1 25	1 25
Treatment of ores or minerals, without heat, in an industry in this group	70	70
Iron smelting, as a business	2 00	2 00
Treatment of ores or minerals, with heat, N.O.S., as a business	1 20	1 20
Treatment of ores or minerals, without heat, N.O.S., as a business	60	60
Refining of nickel, as a business	1 50	1 50
Sand, shale, clay or gravel pits	4 00	4 00
Quarries, as a business; stone crushing	6 00	6 00

Table of Fatalities

	1917	1918	1919	1920	1921
Mines, underground	19	11	21	15	11
Mines, surface	7	4	6	6	1
Metallurgical works	6	12	10	3	4
Quarries	4	5	2	5	8
Totals	36	32	39	29	24

By months, the fatalities occurred as follows:

January	1
February	1
March	3
April	4
May	2
June	2
July	1
August	1
September	3
October	3
November	1
December	2
Total	24

Classifying the fatalities according to the industry gives the following:

Nickel mines and smelters.	2
Iron mines and blast furnaces.	3
Iron pyrites mines.	1
Silver mines and smelters.	4
Gold mines and mills.	6
Limestone quarries.	5
Gravel pits.	3
Total.	24

Analysis of Fatalities at Mines

	1917 Per cent.	1918 Per cent.	1919 Per cent.	1920 Per cent.	1921 Per cent.
Falls of ground.	15.4	20.0	22.2	23.8	33.33
Shaft accidents.	15.4	0.0	29.6	9.5	16.66
Explosives.	15.4	40.0	7.4	23.8	16.66
Miscellaneous underground.	26.9	26.6	18.5	14.3	25.00
Surface.	26.9	13.3	22.2	28.6	8.33

Table of Fatal Accidents in Mines, Metallurgical Works and Quarries, 1901 to 1921

	Persons killed at metallurgical works and mines.	Persons employed at metallurgical works and producing mines.	Persons employed at non-producing mines (estimated).	Total persons employed	Fatal accidents per 1,000 employed.
1901	13	4,135	550	4,685	2.77
1902	10	4,426	450	4,876	2.05
1903	7	3,499	400	3,899	1.79
1904	7	3,475	400	3,875	1.80
1905	9	4,415	500	4,915	1.83
1906	11	5,017	750	5,767	1.90
1907	22	6,305	1,140	7,445	2.93
1908	47	7,435	1,750	9,185	5.11
1909	49	8,505	2,000	10,505	4.66
1910	48	10,862	2,000	12,862	3.73
1911	49	12,543	2,000	14,543	3.37
1912	43	13,108	2,000	15,108	2,84
1913	64	14,293	2,000	16,293	3,93
1914	58	14,361	1,500	15,861	3.60
1915	22	13,114	1,500	14,614	1,51
1916	51	14,624	2,000	16,624	3.07
1917	36	16,791	1,000	17,791	2.02
1918	32	14,726	500	15,226	2.10
1919	39	11,926	1,000	12,926	3.00
1920	29	10,486	1,000	11,486	2.61
1921	24	8,436	1,000	9,436	2.54

Fatalities classified according to occupation and nationality:

Occupations and nationalities of the men killed were:

Occupation.	English Speaking	Italian	Russian	Norwegian	Finn	Pole	Roumanian	Ukrainian	Total
Miner	1	2	1				1	1	6
Foreman	4			1					5
Laborer	1		1						2
Blaster	1					1			2
Teamster	2								2
Repairman	1								1
Conductor	1								1
Skiptender	1								1
Shaftman					1				1
Pipefitter		1							1
Trammer	1								1
Deckman	1								1
Total	14	3	2	1	1	1	1	1	24

Table of Fatal Accidents in or about

No.	Date	Name of Mine.	Name of Owner.	Name.	Occupation.
1	May 8	Coniagas	Coniagas Mines, Ltd.	Arthur Walker.	Skip tender
2	Nov. 28	Dome	Dome Mines Co., Ltd.	W. Alini	Shaftman
3	Apl. 13	Hollinger	Hollinger Consolidated Gold Mines, Ltd.	D. Racuba	Miner
4	July 22	"	" "	A. Janice	Blaster
5	Dec. 6	"	" "	L. Spada	Pipefitter
6	Mar. 10	Creighton	International Nickel Co. of Canada	Albert Smith	Miner
7	Dec. 12	Kirkland Lake	Kirkland Lake Gold Mining Co., Ltd	S. Donaldson	Foreman
8	June 9	McIntyre	McIntyre Porcupine Mines, Ltd	P. Cimetta	Miner
9	Oct. 17	Buffalo	Mining Corp. of Canada	H. B. Smith	Trammer
10	Mar. 9	Victoria	Mond Nickel Co., Ltd	G. Kramar	Miner
11	June 8	Northpines	Nichols Chemical Co.	H. Goluk	Miner
12	Apl. 27	Myer	Nipissing Mining Co.	A. Pope	Deckman

Table of Fatal Accidents at

No.	Date	Name of Works.	Name of Owner.	Name.	Occupation.
13	Mar. 24	Blast Furnace	Algoma Steel Corporation.	Thos. E. Bell	Repair man
14	May 1	Slag Dump	" " "	Albert Dore	Conductor
15	Feb. 7	Caste house	Canadian Furnace Co.	A. Selick	Labourer
16	Apl. 23	Smelter	Deloro Smelting & Refining Co.	G. Tompkins	Labourer

Table of Fatal Accidents at

No.	Date.	Name of Works.	Name of Owner.	Name.	Occupation.
17	Sept. 2	Washago Quarry	Dept. Public Highways	L. Campoli	Miner
18	Oct. 21	Quarry	Lincoln County	L. Glendenning.	Blaster
19	Oct. 27	Quarry	Ontario Reformatory	N. J. Agnew	Superintendent.
20	Aug. 6	Quarry	Standard White Lime Co.	W. J. Culford	Foreman
21	Jan. 29	Gravel Pit	Townsend Twp	A. R. King	Teamster
22	Apl. 22	Quarry	Woodland & Co.	W. Woodland	Foreman
23	Sept. 15	Gravel pit	Wright & Co.	A. Nilsen	Foreman
24	Sept. 16	Gravel pit	York County	S. Ball	Teamster

Mines of Ontario during 1921.

Nationality.	Age	Married or Single	Above ground	Below ground	Cause of Accident.
English.......	50	M	......	1	Fell in shaft.
Finn..........	36	M	......	1	Fell in shaft.
Russian.......	44	M	......	1	Caught by run of ore in mill hole.
Pole..........	35	S	......	1	Walked into blast.
Italian........	34	M	......	1	Struck by box in drill chute.
English.......	31	M	......	1	Fall of ground in stope.
Canadian......	37	M	......	1	Fall of ground in stope.
Italian........	20	S	......	1	Drilled into explosive.
English.......	32	M	......	1	Fall of ground from wall of open pit.
Roumanian....	26	S	......	1	Fell from bench into stope.
Ukrainian.....	30	M	......	1	Fall of ground in crosscut.
English.......	24	S	1	......	Struck by runaway car.

Metallurgical Works, 1921.

Nationality.	Age.	Married or Single.	Cause of Accident.
Canadian.......	49	M	Crushed between engine and post.
Canadian.......	35	M	Burned by molten slag.
Russian........	40	M	Struck by cast of iron when chain broke.
Canadian.......	51	M	Electrocuted.

Quarries, Clay and Gravel Pits, 1921.

Nationality.	Age.	Married or Single.	Cause of Accident.
Italian.........	26	M	Explosion while loading holes.
Canadian.......	24	S	Picked into explosive.
Canadian.......	35	M	Struck by flying rock from explosion.
Canadian.......	34	S	Electrocuted.
Canadian.......	30	S	Bank undermined and fell.
Canadian.......	57	M	Remained too long lighting fuses.
Norwegian.....	50	M	Fall of sand threw him against wheelbarrow.
English........	35	M	Bank undermined and fell.

Ages of the men killed:

Age	17-20	21-25	26-30	31-35	36-40	41-45	46-50	51-55	56-60	Total.
No. killed.	1	2	4	8	3	1	3	1	1	24

Fatalities at mines classified according to cause and place:

Below Ground:

Falls of ground	4
Shaft accidents	2
Explosives	2
Buried in stope	1
Fell into open stope	1
Miscellaneous	1

Above Ground:

Struck by car	1

Non-fatal Accidents Classified According to Occupation and Nationality of Men Injured (Mines)

Mines—Surface and Underground	English Speaking	Italian	Austrian	Russian	Finn	Pole	Roumanian	Ukrainian	Bulgarian	French	Spaniard	Galician	German	Swede	Belgian	Serbian	Total
Miner	167	47	35	15	17	20	11	7	2	2	2	3		1	1		330
Trammer	44	28	21	8	6	7	12		3	3	3	1	2				138
Labourer	80	16	3	4	3	2	2	3					1				114
Mechanic	30	3	1						1								35
Chute loader	13	6	1	4		2		2									28
Mill worker	25	2															27
Timberman	15			1	5					1							22
Carpenter	17									1							18
Pipefitter	5	8			1												14
Blacksmith	7	1					1	2			2						13
Scaler	3	3		3	1		2										12
Foreman	8		1						1								10
Electrician	8																8
Deckman	7					1											8
Nipper	4	1	2		1												8
Engineer	7																7
Teamster	6									1							7
Motorman	4	2							1								7
Chute blaster	1		2	1					1			1					6
Cage tender	2		2				1										5
Crusherman	4																4
Sampler	4																4
Shaftman	1	1			1												3
Sorter	1	2															3
Trackman	1	1															2
Blaster				1												1	2
Assayer	2																2
Cook	2																2
Fireman	1																1
Furnaceman	1																1
Brakeman	1																1
Clerk	1																1
Total	472	121	68	37	35	32	29	14	9	8	7	5	3	1	1	1	843

Causes of Non-fatal Accidents (Mines)

Mines	Surface	Under-ground	Total
Working at chute		110	110
Slipped or tripped and fell	36	37	73
Crushed or hit by car or motor	10	53	63
Falling Rock		56	56
Sprain or strain	16	34	50
Foreign matter in eye	19	30	49
Struck by falling objects	25	22	47
Handling rock, scaling	7	38	45
Fingers crushed	16	24	40
Injured by hand tools	20	16	36
Rock rolling down pile	3	32	35
Infection	14	15	29
Injured by drill steel	4	23	27
Fell from elevation	11	13	24
Injured by drill		16	16
Caught by machinery	14		14
Struck by hammer	5	9	14
Struck by flying objects	5	7	12
Flesh punctured by nail	3	9	12
Burned or scalded	8	3	11
Injured by timber		11	11
Falling off ladder	1	10	11
Cut by metal, scrap, etc	8		8
Injured by cage or skip		8	8
Collapse of staging	1	6	7
Miscellaneous	5	2	7
Injured by animals	2	3	5
Injured by bar		5	5
Injured by machinery	4	1	5
Caught by belt	5		5
Injured by particles dislodged by drill		4	4
Electric burns	3		3
Poisoning	1		1
Total	246	597	843

Causes of Non-Fatal Accidents (Metallurgical Works)

Hit by falling objects	25
Slipped or tripped and fell	20
Burned or scalded	20
Foreign matter in eye	17
Fall from elevation	15
Injured by cars, ladles, etc.	13
Burned at furnace	11
Burned by slag, matte, etc.	10
Sprain	9
Caught by machinery	8
Injured by bar	8
Crushed between two objects	7
Injured by tools	7
Hit by hammer	6
Handling rock or matte	5
Internal injury carrying load	5
Hit by flying objects	4
Burned by explosion of slag or matte	3
Infection from wound	3
Poisoned	3
Injured by slag pot	3
Cut by metal, scrap, etc.	2
Stepped on nail	2
Injured by train	2
Electric burn	1
Gas asphyxiation	1
Fall from vehicle	1
	211

Occupation and Nationality of Men Injured (Metallurgical Works)

	English speaking	Italian	Austrian	Chinese	Russian	Pole	French	Roumanian	Finn	Serbian	Belgian	Galician	Ukrainian	Total
Labourer	45	32	7	2	4	4	2	1	....	1	2	....	1	101
Furnace man	11	2	1	....	1	1	2	....	....	....	....	....	....	18
Mechanic	11	1	....	....	1	....	....	....	....	....	....	....	....	13
Furnace helper	6	3	....	2	....	....	....	1	....	....	....	....	....	12
Foreman	9	....	....	....	....	....	....	1	....	1	....	....	....	11
Carpenter	6	....	....	....	....	....	....	....	1	....	.	1	....	8
Trainman	6	....	....	....	....	....	....	....	....	....	....	....	....	6
Tuyere puncher	3	1	....	2	....	....	....	....	....	....	....	....	....	6
Crane man	4	....	1	....	....	....	....	....	....	....	....	....	....	5
Pipefitter	4	....	....	....	....	....	....	....	1	....	....	....	....	5
Blacksmith	2	1	....	....	....	....	....	....	....	....	....	....	....	3
Weigher	3	....	....	....	....	....	....	....	....	....	....	....	....	3
Fireman	3	....	....	....	....	....	....	....	....	....	....	....	....	3
Crusherman	1	....	....	1	....	....	....	....	....	....	....	....	....	2
Scrapper	....	2	....	....	....	....	....	....	....	....	....	....	....	2
Cokeman	1	1	....	....	....	....	....	....	....	....	....	....	....	2
Teamster	2	....	....	....	....	....	....	....	....	....	....	....	....	2
Clerk	2	....	....	....	....	....	....	....	....	....	....	....	....	2
Converter man	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Hoistman	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Trackman	....	1	....	....	....	....	....	....	....	....	....	....	....	1
Oiler	....	1	....	....	....	....	....	....	....	....	....	....	....	1
Electrician	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Trammer	1	....	....	....	....	....	....	....	....	....	....	....	....	1
Motorman	....	....	....	....	1	....	....	....	....	....	....	....	....	1
Total	123	45	9	7	7	5	4	3	2	2	2	1	1	211

Occupation and Nationality of Men Injured (Quarries, Clay and Gravel Pits)

Occupation	English speaking	Italian	Roumanian	Austrian	Russian	Ukrainian	Finn	Pole	Total
Labourer	105	24	2	1	2	2	......	1	713
Quarry man	12	2	1	2	......	......	......	......	17
Teamster	14	......	......	......	......	......	......	......	14
Shovel craneman	8	1	......	......	......	......	......	......	9
Foreman	6	......	......	......	......	......	......	......	6
Blacksmith	4	......	......	......	......	......	1	......	5
Fireman	4	......	......	......	......	......	......	......	4
Watchman	2	......	1	......	......	......	......	......	3
Brakeman	3	......	......	......	......	......	......	......	3
Machinist	3	......	......	......	......	......	......	......	3
Carpenter	3	......	......	......	......	......	......	......	3
Engineer	1	......	......	......	......	......	......	......	1
Crusherman	1	......	......	......	......	......	......	......	1
Electrician	1	......	......	......	......	......	......	......	1
Blaster	1	......	......	......	......	......	......	......	1
Total	168	27	4	3	2	2	1	1	208

Causes of Non-fatal Accidents (Quarries, Clay and Gravel Pits)

By material while loading at face ..	44
By machinery	23
By timber or hand tools	21
By haulage accidents	20
By flying pieces of rock from sledging	16
By falls or slides of rock, clay or gravel	16
By quarry cars or locomotives	14
By slipping or stumbling	10
By drilling accidents	10
By falling from hoists, derricks or ladders	9
By explosives	6
By falling from surface, benches, or face	4
By stepping on nail	4
By burns	4
By electricity	2
By other causes	5
	208

Classification of Explosive Accidents

	Non-fatal.	Fatal.
Explosion, while tamping..........	3	1
Drilled into explosive..........	2	1
Struck unexploded charge with hammer or pick..........	1	1
Detonators..........	1	....
Premature explosion..........	2	1
Hit by rock from explosion..........	1	1
Walked into blast..........	....	1
Explosion while shovelling..........	2	....
Total..........	12	6

Prosecutions

At Kirkland Lake, on June 10, Andrew Kakar pleaded guilty to riding on May 3 in empty cars on the cage at the Teck-Hughes Gold Mines, in violation of Rule 75, Section 164, of the Mining Act. Reeve John McLennan imposed a fine of $20.00 and costs.

Testing Hoisting Cables.

Rule 68, Section 164, of the Mining Amendment Act, 1919, being Part IX, of the Mining Act of Ontario, is as follows:

TESTING PORTION OF ROPE.

(68) At least once in every six months the hoisting rope shall have a portion not less than six feet in length cut off the lower end. With the exception of the cutting at the end of the first six months the length so cut off shall have the ends adequately fastened with binding wire to prevent the disturbance of the strands and shall be sent to a reliable testing laboratory for a breaking test. The certificate of such test shall be kept on file. This rule shall not come into effect until proclaimed by the Lieutenant-Governor in Council.

This rule was by Order in Council dated 7 December, 1921, brought into effect on 1 January, 1922, and proclamation of same was duly made in *The Ontario Gazette.*

In order to distribute the work in the testing laboratory the Department decided to make this regulation apply as follows:

In the Mining Division of Kenora, Fort Frances, Kowkash and Port Arthur, on the first day of January, 1922;

In the Mining Divisions of Sault Ste. Marie, Sudbury and Parry Sound, on the first day of February, 1922;

In the Mining Divisions of Temiskaming, Coleman, Montreal River and Gowganda, on the first day of March, 1922;

In the Porcupine Mining Division, on the first day of April, 1922;

In the Larder Lake Mining Division, on the first day of May, 1922;

And in all other parts of the Province, on the first day of June, 1922.

The requirements as to the portion of cable for testing purposes are as follows:

The portion of cable sent to the testing laboratory shall be the six feet above the socket or clamps. This test piece shall be kept free from bends and shall be shipped in a box, or attached by staples to a two-inch board, six feet six inches in length. The ends shall be wrapped in burlap to prevent injury to persons in handling. Before cutting, at least two seizings or servings of soft iron wire, each about one and a half inches long, shall be placed tightly upon the rope at a distance apart equal to the length of the test specimen (72 inches). If the ends of wire rope are not properly secured, the relation of tensions in the rope will be disturbed; hence it is most important that proper seizings be placed at each side of any point at which the rope is to be cut, and, if possible, two or three seizings should be employed at each side of a cut. Annealed iron wire should be used, the suitable sizes being from .054-inch diameter for half-inch rope up to .080-inch diameter for rope one inch in diameter and .105-inch for rope two inches in diameter.

The following information regarding the rope should be sent to the Department of Mines: name of manufacturer; diameter of rope; estimated breaking load as supplied by the manufacturer; name of shaft and compartment in which rope is used; date rope was put in use; and breaking load at previous test. Address, Mines Inspection Branch, No. 5 Queen's Park, Toronto, Ontario.

The laboratory at No. 5 Queen's Park is equipped with a 300,000-pound-capacity Tinius Olsen latest improved testing machine of four-screw type with special length screws and columns so arranged that the maximum clearance between the weighing table and lower surface of the lower or moving crosshead is six feet four inches, and with two positions in the columns for supporting the upper crosshead. The machine is equipped with automatic beam and speed regulating cones and with direct-connected motor drive. Instead of the ordinary rectangular holders and wedge-grip tools for tensile tests, the crossheads have conical holes. All cables are socketed in zinc for breaking tests.

Until further notice the rates charged will be according to the following schedule. Cables up to and including 7/8-inch diameter, $10.00; 1-inch and 1 1/8-inch, $12.00; 1 1/4-inch, $15.00; over 1 1/4-inch, $20.00.

MINES OF ONTARIO

By

Chief Inspector of Mines, T. F. Sutherland, Toronto; Inspectors, J. G. McMillan, Cobalt; James Bartlett, Sudbury; A. R. Webster, Toronto; G. E. Cole, Ottawa.

The system of mine inspection in use in Ontario provides for the visitation of all working mines and metallurgical works, in order to see that the provisions of the Mining Act for the protection of mines and workmen are duly observed. These visits are made as often as the time of the inspectors will admit, or as occasion seems to require. In their examinations the inspectors also obtain particulars regarding mining and development work, and their notes are summarized in the following pages. Shareholders and the public generally are thus enabled to follow from year to year the rise and progress of any particular property in which they may be interested. First is given a classified list of the mines and metallurgical works inspected during 1921, the period covered by the Report.

MINES AND PROSPECTS INSPECTED, 1921

Name	Owner.	Manager.	Address.
CALCITE AND DOLOMITE.			
Baptiste	Ontario Dolomite Manufacturing Co., Ltd.	Alex. Watson	76 Coleridge Ave., Toronto.
Caldwell	T. B. Caldwell		Perth.
COPPER.			
Algomont	Algomont Mines, Ltd.	Geo. Johnson	Rydal Bank.
Jewel	Jewel Gold and Copper Mining Co., Ltd.	W. J. Hands	Webbwood.
CORUNDUM.			
Craigmont	Corundum, Ltd.	E. B. Clark	Craigmont.
FELDSPAR.			
Emery	Eureka Flint and Spar Co.	R. Wagar	Verona.
Richardson	Feldspars Limited	Ralph Scott	Hartington, R.R. 1.
Babcock	Gardner Feldspar Co.	J. H. Mendels	Perth.
Hoppins	International Feldspar Co., Ltd.	John A. McLean	316 Moffat Block, Detroit, Mich.
Long Lake	Orser and Wilson	Sherman Orser	Perth.
Keays	Rinaldo McConnell	Rinaldo McConnell	Perth.
Kirkham	" "	" "	"
Watson	Mount Eagle Feldspar Co., Ltd.	M. B. R. Gordon	Hybla.
Burns	Orser-Kraft Feldspar, Ltd.	Sidney H. Orser	Perth.
Keays	" "	" "	"
Morrow	" "	" "	"
Woodcock	Pennsylvania Pulverizing Co.	R. H. Thompson	Hybla.
Robinson	Harry J. Cain		Tichborne.
Noonan	Rock Products Co.	A. G. Minehart	Toledo, Ohio.
Keays	" "	" "	" "
Clobridge	" "	" "	" "

MINES AND PROSPECTS INSPECTED, 1921—*Continued.*

Name	Owner	Manager	Address
Teeples	Storrington Feldspar Co., Ltd	C. G. Walton	Elgin.
Vanluven	A. Vanluven		Holleford.
McDonald	Verona Mining Co	W. B. Couch	Hybla.
FLUORSPAR.			
Wallbridge	Wallbridge Bros		Madoc.
GOLD.			
Argonaut	The Argonaut Gold, Ltd	J. W. Morrison	Dane.
Beaumont	The Beaumont Gold Mines, Ltd	S. H. Allen	South Porcupine.
Bidgood	The Bidgood Gold Mines, Ltd	D. H. Angus	Kirkland Lake.
Big Dyke	The Big Dyke Gold Mines, Ltd		Timmins.
Blanche Bay	The Blanche Bay Syndicate	Richard Haggerty.	Kenogami.
Cartwright	The Blue Quartz Gold Mines, Ltd	J. J. Hollinger	Matheson.
Bousquet	Bousquet Gold Mines, Ltd	Robt. B. Tough	Willisville.
Burke	Under option to Hollinger. Consolidated Gold Mines, Ltd.,		West Tree.
Goldale	Goldale Mines, Ltd.	H. A. Kee	Schumacher.
Goldfields	Canadian Associated Gold Fields, Ltd	Geo. Gray	Dane.
Golden Fleece	The Cobalt Frontenac Mining Co	D. H. Fletcher	Flinton.
Bonanza	Contact Bay Mines, Ltd	E. R. Rognon	Dryden.
Costello	Crown Reserve Mining Co., Ltd	H. J. Stewart.	Dane.
Detroit	Detroit Goudreau Gold Development Co., Ltd	C. G. Daimpré	Goudreau.
Dome	Domes Mines Co., Ltd	H. P. De Pencier	South Porcupine.
Summit	The Golden Summit Mining Co., Ltd	J. T. Kerr	Windsor.
Murphy	Goudreau Gold Mines, Ltd.	W. H. Reamsbottom	Goudreau.
Superior	Goudreau-Superior Mining Co., Ltd	C. G. Daimpre	Goudreau.
Grace (On Eagle Lake)	Grace Mining Co., Ltd	W. J. Richards	Kenora.
Hayden	Hayden Gold Mines, Ltd	W. H. Hayden	Timmins.
Hollinger	The Hollinger Consolidated Gold Mines, Ltd	A. F. Brigham	Timmins.
Hologden	Hologden Mines, Ltd	Hart Martin	North Bay.
Howry Creek	The Howry Creek Mining Corporation, Ltd	A. K. Anderson	Ottawa.
Jackson	The Jackson Development Co., Ltd	W. S. Jackson	Schreiber.
King	The King-Kirkland Gold Mines, Ltd	C. F. Jordan	Haileybury.
Kirk	Kirk Gold Mines, Ltd	E. H. Birkett	Havilah.
Combined	Kirkland Combined Mines, Ltd	A. W. Grierson	Kirkland Lake.
Kirkland Lake	The Kirkland Lake Gold Mining Co., Ltd	W. M. Sixt	Kirkland Lake.
Lake Shore	The Lake Shore Mines, Ltd	R. C. Coffey	Kirkland Lake.
Lightning River	Lightning River Gold Mines, Ltd	J. W. Morrison	Dane.
Majestic	Majestic Gold Mines, Ltd.	M. A. Attalah	West Rive

MINES AND PROSPECTS INSPECTED, 1921—*Continued.*

Name	Owner	Manager	Address
McIntyre	McIntyre Porcupine Mines, Limited	R. J. Ennis	Schumacher.
Longworth	McKellar-Longworth	W. L. Longworth	Port Arthur.
Mikado	Mikado Consolidated Mines, Ltd	H. A. C. Machin	Kenora.
Miller-Adair	Miller-Adair Mines, Ltd	Chas. Miller	Toronto.
Miller Independence	Miller Independence Mines, Ltd	W. E. Simpson	Boston Creek.
Montreal-Kirkland	Montreal-Kirkland Mines Ltd	B. G. Killoran	Haileybury.
Northcrown	Northcrown Porcupine Mines, Ltd	H. J. Stewart	Timmins.
Ontario-Kirkland	Ontario-Kirkland Gold Mines, Ltd	Ralph Hurd	Kirkland Lake.
Ore Chimney	Ore Chimney Mining Co., Ltd	A. E. Fletcher	Northbrook.
Davidson	Porcupine Davidson Gold Mines, Ltd	N. J. Evered	South Porcupine.
Peninsular	Porcupine Peninsular Gold Mines, Ltd	A. R. Globe	Connaught.
Keora	Porcupine Keora Gold Mines, Ltd	J. C. Waite	South Porcupine.
Queen Lebel	Queen Lebel Gold Mines, Ltd	E. B. Wood	Haileybury.
Skead	Skead Gold Mines, Ltd	M. L. Bouzan	Haileybury.
St. Anthony	C. L. Campbell et al	C. L. Campbell	Montreal.
Teck Hughes	Teck Hughes Gold Mines Ltd	D. L. H. Forbes	Kirkland Lake.
Thesaurus	Thesaurus Gold Mines, Ltd	J. C. Nelson	Matachewan.
Tough Oakes	Tough Oakes Gold Mines	W. R. Thomas	Kirkland Lake.
Triplex	Triplex Gold Mines, Ltd	D. B. Harrison	South Porcupine.
Union	Union Mining Corp., Ltd	C. T. Denker	Timmins.
Wasapika	Wasapika Consolidated Mines. Ltd	G. R. Rogers	Coyne, Ont.
White Rock	White Rock Mining Co., Ltd	J. McVittie	Sudbury.
Wright-Hargraves	The Wright-Hargraves Mines, Ltd	A. Wende	Kirkland Lake.
GRAPHITE			
Black Donald	Black Donald Graphite Co	R. F. Bunting	Calabogie.
GYPSUM.			
Caledonia	Ontario Gypsum Co., Ltd	A. J. Parkhurst	Caledonia.
Lythmore	“ “	“ “	“
IRON.			
Magpie	Algoma Steel Corp	G. R. McLaren	Magpie Mine.
Mason-Wilcox	Mason-Wilcox Syndicate		Sault Ste. Marie.
Moose Mountain	Moose Mountain, Ltd	A. J. Anderson	Sellwood.
Palatine	Palatine Mining and Development Co	Arthur Mitchell	Duluth.
Atikokan	Under option to Clement A. Quinn		Duluth.
Goulais River	Under option to Chas. R. Sligh		Grand Rapids, Mich.

MINES AND PROSPECTS INSPECTED, 1921—*Continued.*

Name	Owner	Manager	Address
IRON PYRITES.			
Northpines	Nichols Chemical Co.	J. P. Flynn	Northpines.
Sulphide	“ “	W. H. De Blois	Sulphide.
Rand	Rand Consolidated Mines, Ltd.	A. H. Jackson	Buffalo.
LEAD.			
Hollandia	Arnprior Syndicate	C. Thompson	Arnprior.
Kingdon	Kingdon Mining Smelting and Manufacturing Co.	R. R. Rose	Galetta.
Frontenac	Northern Lead Co.	J. B. Bell	Montreal.
MICA.			
Acton	Acton Mines, Ltd	C. J. Acton	Gananoque.
Howes	H. J. Cain	H. J. Cain	Tichborne.
Folger	“ “	“ “	“
Lacey	Loughborough Mining Co.	G. W. McNaughton	Sydenham.
MOLYBDENITE.			
Wilberforce	American Molybdenites, Ltd	W. E. T. Barton	Wilberforce.
NICKEL.			
Murray	British America Nickel Corporation	E. Hibbert	Nickelton.
Creighton	International Nickel Co.	J. L. Agnew	Copper Cliff.
Bruce	Mond Nickel Company	A. D. Carmichael	Bruce Mines.
Garson	“ “	A. L. Sharp	Garson.
Levack	“ “	F. J. Eager	Levack.
Victoria	“ “	W. J. Mumford	Mond.
Worthington	“ “	A. D. Carmichael	Worthington.
SILVER.			
Chambers-Ferland	Aladdin Cobalt Co., Ltd.	J. Matheson	Cobalt.
Alpine	Alpine Silver Mines, Ltd.	E. J. Thompson	Gowganda.
Bailey	Bailey Silver Mines, Ltd.	R. E. Dye	Cobalt.
Cobalt A-53	Cobalt A-53 Silver Mining Co., Ltd.	J. J. Byrne	Cobalt.
Collins	F. Howard Collins	F. H. Collins	Gowganda.
Coniagas	The Coniagas Mines, Ltd.	F. D. Reid	Cobalt.
Dickson Creek	The Dickson Creek (Cobalt) Silver Mines, Ltd.	H. Hollands-Hurst	Haileybury.
Federal	The Federal Mining Co., Ltd.	Wiley	Port Arthur.
Frontier	Dominion Mines & Quarries	H. F. Strong	Haileybury.
Keeley	The Keeley Silver Mines	J. Mackintosh Bell	Silver Centre.
Kerr Lake	Kerr Lake Mines, Ltd.	H. A. Kee	Cobalt.
La Rose	La Rose Mines, Ltd.	G. C. Bateman	Cobalt.
Princess	“ “	“ “	“
University	“ “	“ “	“
Violet	“ “	“ “	“
Mining Corporation	The Mining Corporation of Canada, Ltd.	M. F. Fairlie	Cobalt.
Nipissing	Nipissing Mines Co., Ltd.	Hugh Park	Cobalt.
Miller Lake O'Brien	M. J. O'Brien, Ltd.	H. G. Kennedy	Gowganda.
O'Brien	“ “	J. G. Dickenson	Cobalt.
Northcliffe	Northcliffe Mines, Ltd.	N. E. Dye	Gowganda.
Solid Silver	Ontario Solid Silver Mines.	Roy Sullivan	Elk Lake.
Oxford Cobalt	Oxford Cobalt Silver Mines	J. W. Russell	Cobalt.
Reliance	Hermo Leasing Co.	W. H. Emens	Cobalt.

MINES AND PROSPECTS INSPECTED, 1921—*Continued.*

Name	Owner	Manager	Address
Sanderson	Under option to Stewart Troop		Montreal.
Shoefelt	Jacob Shoefelt	W. H. Todd	McLennan.
Silver Cliff	Under lease to Bailey Silver Mines, Ltd	G. C. Bateman	Cobalt.
Silver Islet	The Islet Exploration Co., Ltd	D. C. Peacock	Port Arthur.
Silver Queen	Under lease	W. J. Post	Cobalt.
Castle	Trethewey Silver Cobalt Mining Co	M. D. Kennedy	Gowganda.
Victory	Victory Silver Mines, Ltd	J. A. McVichie	Cobalt.
TALC.			
Connolly	Asbestos Pulp Co	H. B. Hungerford	Madoc.
Price	" "	" "	"
Henderson	Geo. H. Gillespie & Co	Geo. H. Gillespie	Madoc.

METALLURGICAL WORKS INSPECTED, 1921

Works.	Owner.	Manager.	Address.
Blast Furnaces	Algoma Steel Corporation	James D. Jones	S. S. Marie.
" "	Canadian Furnace Co	G. J. Higgins	Port Colborne.
" "	Steel Company of Canada	H. G. Hilton	Hamilton.
Silver-Cobalt Refinery	Coniagas Reduction Co	D. A. Mutch	Thorold.
" " "	Doloro Smelting and Refining Company	S. B. Wright	Deloro.
Nickel Refinery	International Nickel Co	John More	Port Colborne.
Cobalt Refinery	Ontario Smelters and Refiners	J. F. Hickling	Welland.

1.—NORTHWESTERN ONTARIO

Gold

Contact Bay Mines, Limited.—This company shut down its Bonanza mine on December 31, 1921, and resumed mining in the spring.

When last inspected, March 9, 1922, the shaft, an 80-degree incline, measured 170 feet. On the 80-foot level there was 214 feet of drifting to the east, 170 feet to the west, and a 90-foot inclined raise to the surface. On the 160-foot level drifting was in progress, and the faces were then 125 feet east and 135 feet west of the shaft.

Harry S. Badger, who has been manager for the company for some years, left the company's employ in March, 1921; E. R. Rognon is now acting as managing director. E. S. Henley, superintendent, resigned in September, and was succeeded by Charles W. Riley.

Empress.—The Empress mine near Jackfish was pumped out and sampled in 1921 by an American syndicate. The mine is owned by the Czarina Gold Mines Company of Ontario, Limited, which was incorporated August 28, 1901, with a capital of $40,000, and which succeeded the Empress Gold Mining Company of Ontario, Limited. The last officers of the company were: president, D. McKellar, Fort William, (now deceased); vice-president, Walter Ross, Lethbridge, Alta.; secretary-treasurer, W. L. Morton, Fort William.

Grace, (Eagle Lake).—The Grace gold mine on the west side of Eagle lake in the Manitou lake area was worked during nine months of the year. Captain Walpole Roland was at first in charge, but was succeeded by William J. Richards of Kenora in June. The mine is owned by The Grace Mining Company, Limited, of 8 Brisbane Building, Buffalo, N.Y. The directors are: George J. Blake, president; Charles Oelheim, secretary and treasurer; and Charles P. Blake; all of Buffalo, N.Y. The post office address for the mine is Vermilion Bay, Ont.

When work was discontinued for the winter on December 15, 1921, the two-compartment shaft was 187 feet deep and had an average dip of 86 degrees. On the first level, which is at about 100 feet, there is a crosscut running northwest to the vein a distance of 20 feet from the shaft, and from the face of this crosscut drifts extend about 15 feet to the northeast and 25 feet to the southwest; the work on the first level was done between 15 and 20 years ago. On the second, or 180-foot level there is a crosscut 45 feet to the northwest and a second 45 feet to the southeast, but no drifting has been done.

Jackson.—The Jackson Development Company, Limited, owns eight mining claims on the Canadian Pacific Railway about two miles east of Schreiber. The claims are: T.B. 3326, T.B. 3411, T.B. 3413, T.B. 3588, T.B. 3589, T.B. 3815, T.B. 3783, and T.B. 3795. For the past seven years the prospecting of these claims has been carried on under the direction of Wm. S. Jackson.

When the property was last inspected in March, 1922, ten men were employed and two adits were being driven into the side of a hill on claim T.B. 3326 a short distance north of the railway. No. 1 adit measured 60 feet and No. 2 adit 40 feet. No underground work has been done on the other claims. The buildings on the property consist of a dining room, a sleeping camp, two small cabins, a stable, and an ore bin with sorting room attached.

The company was incorporated on October 1, 1921, with a capitalization of $40,000. One-half of the stock has been sold at par, and the remainder is in the treasury. The officers are: president, W. H. Russell, Port Arthur; vice-president, Chas. N. Gray, Detroit; secretary, W. F. Langworthy, Port Arthur; treasurer, Wm. S. Jackson, 297 Frederick Street, Fort William; directors,—the above-mentioned and,—Alex. D. Hunt, Port Arthur, and Harold D. Emmons, Detroit, Mich. The head office is at Port Arthur, Ont., and the address for the mine is Box 107, Schreiber, Ont.

McKellar-Longworth.—The veins on the McKellar-Longworth property, mining location B.J. 122, are described elsewhere in this report by P. E. Hopkins of the geological staff.

The property was inspected March 16, 1922, when ten men were at work under foreman J. B. Amm. The adit on the vein then measured 85 feet, the north crosscut 59 feet, and the south crosscut 30 feet. No. 2 shaft was 20 feet deep and No. 4 shaft 40 feet. The owners, Peter McKellar of Fort William and W. L. Longworth of Port Arthur, had just given an option on the property to George Glendinning of Toronto.

Mikado Consolidated.—On November 16, 1921, Mikado Consolidated Mines, Limited, was incorporated under the Ontario Company's Act with a capitalization of $5,000,000 divided into shares of $1.00 par value. Two million shares have been paid for the mining property, leaving three million shares in the treasury.

The company's holdings are situated on Shoal lake and are as follows:

(1) The Mikado mine, consisting of Locations D. 147, D. 148, D. 149, D. 200, D. 201, and D. 201A, some 278 acres in all, with the machinery, 20-stamp mill, and buildings thereupon.

(2) An option to purchase the Tycoon mine, which consists of Locations J.E.S. 54, D. 219, D. 220 and D. 221, some 40 acres in all.

(3) An option to purchase the Bullion mine, which consists of Locations S. 109, S. 126, S. 150, S. 151, D. 233, D. 239, and D. 389, some 447 acres in all.

The Tycoon and Bullion properties adjourn the Mikado mine.

The directors of the company are: president, Lieut.-Col. H. A. C. Machin, Kenora; vice-president, George J. Guy, Hamilton, Ont.; secretary and treasurer, Major George H. Marsh, Toronto; J. T. White, Toronto; A. W. Hunter, Toronto. The head office of the company is in Kenora, but an office is also maintained at Suite 501, Kent Building, Toronto.

St. Anthony.—In January and February, 1921, C. L. Campbell and associates conducted some experiments at the St. Anthony mine on the ore and tailing. This mine is on Couture lake in the Sturgeon lake area.

Wachman.—The Wachman Mining and Milling Company, Limited, made an assignment on January 14, 1922. Since December, 1920, nothing has been done on this company's claims, which are near Dryden, Ont.

Iron

Atikokan.—Early in 1921 Clement A. Quinn of Duluth took an option on the Atikokan iron mine near Atikokan, Ont., but, so far as has been learned, he has not done any mining on the property.

Palatine.—In the spring of 1921 it was announced that the Palatine Mining and Development Company of Chicago, the directors of which are Polish-Americans, had bought the Paulson mine and some adjacent property in Cook County, Minnesota, and the Atikokan blast furnace at Port Arthur, Ont. The company did considerable repair work at the furnaces and began to extend the Port Arthur and Duluth railway from the end of the track at North Lake, Ont., to the Paulson mine, a distance of some 21 miles. The blast furnaces were not put in operation in 1921.

According to a correspondent of the Engineering and Mining Journal the officers of this company are as follows: Joseph Mierzynski, president, Chicago; Frank Wydra, secretary, Chicago; Stanley Grzybowski, treasurer, Chicago; Arthur Mitchell, consulting engineer, Duluth; Thomas Krakowiak, chemical engineer, Palatine City, Minn.; Roman Turczynowicz, construction engineer, Chicago; Maximillian J. St. George, general counsel, Chicago; James Ostrowski, director, Chicago; and Edward A. Zolkowski, director, Chicago.

Iron Pyrites

Northpines.—The Nichols Chemical Company, Limited, worked its Northpines pyrite mine to a small extent in 1921.

From No. 1 shaft crosscuts were driven on the third and fourth levels to the main drifts on the vein. In February the main or No. 2 shaft was completed to the sixth level, and the sixth level station was then cut. Crosscuts to the hanging walls were driven on the fifth and sixth levels, and from a point in the shaft 20 feet above the sixth level an ore-pocket raise was driven to the fifth level and the ore pocket partly excavated. Since September practically no underground work has been done.

From April to September 14,090 tons of pyrite were hoisted and crushed, and 13,635 tons were stockpiled at the railway; the difference between these figures represents the amount of waste removed by sorting.

A 37½-horsepower Type Y Fairbanks-Morse oil engine is being used to furnish power during the shutdown.

J. P. Flynn, Jr., Northpines, is superintendent.

Silver

Federal.—The Federal Mining Company, Limited, owning a mining claim in lot 26, concession B, Paipoonge township, stopped work at the end of 1921, and the underground workings are as described in the Thirtieth Annual Report of this Department.

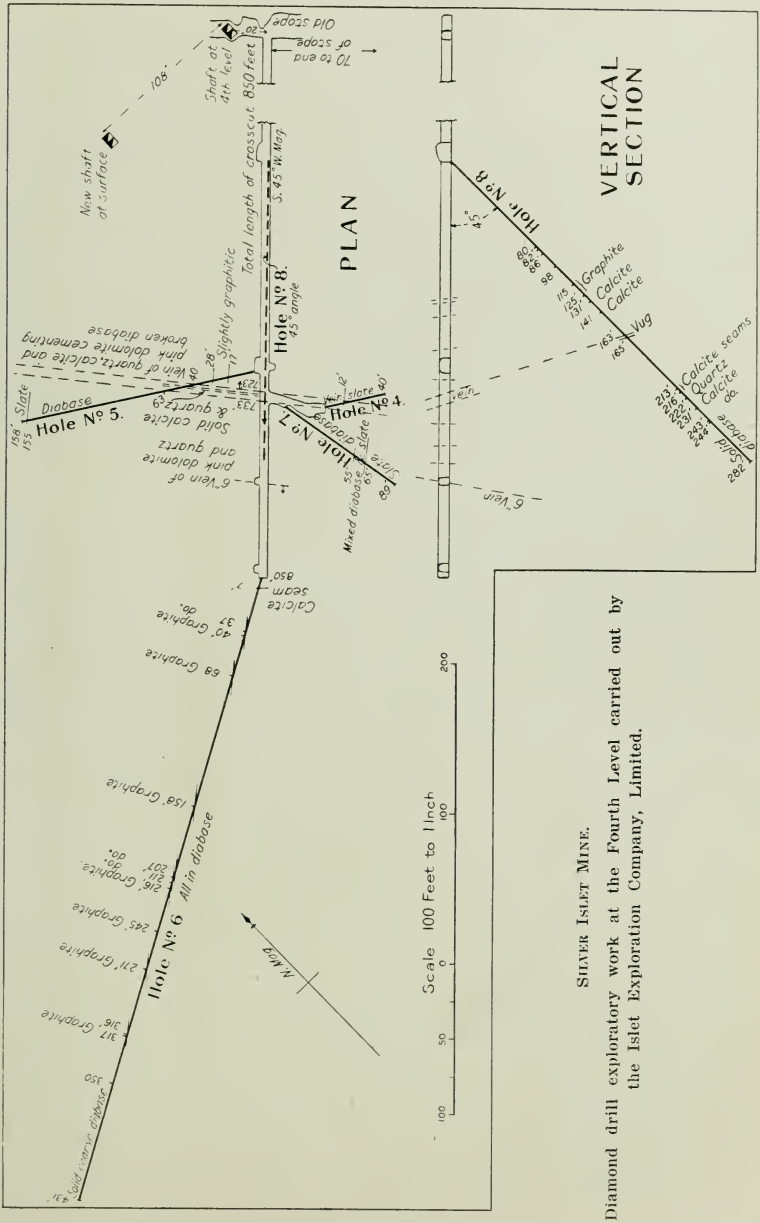
Silver Islet.—Islet Exploration Company, Limited, was incorporated on Jan. 3, 1921 with an authorized capital of $250,000; about $120,000 of this stock has been issued. The officers of the company are: president, J. L. Washburn; vice-president, D. C. Peacock; secretary, A. M. Washburn; treasurer, R. M. Sellwood. The office of the company is at 509 Alworth Building, Duluth, Minn.

This company was formed to search for ore in the Silver Islet mine consequent on the preliminary investigation made in 1920 by R. C. Jamison and D. C. Peacock and described in the Thirtieth Annual Report of this Department.

Mr. Peacock, who, in addition to being the vice-president, is also the mining engineer of the company, has been kind enough to supply the following notes regarding the recent work at this famous mine:

> The work done at Silver Islet in 1921 was confined to the fourth level which is at a vertical depth of 225 feet below the collar of the shaft. A crosscut was driven 850 feet to the southwest in te Macfarlane like and disclosed two veins, one about ten feet in width, and the other about six inches. After a distance of 40 feet had been driven southerly on the 10-foot vein a heavy flow of water was encountered, preventing further work in that direction. Drifting was started northward on the 6-inch vein, but this face also had to be stopped on account of water. It was then decided to resort to diamond drilling to prospect the veins already found and to explore the ground to the southwest for additional veins. Five holes, totalling 1,000 feet, were driven from this level. Practically no silver was found in the veins by crosscut, drifts, or diamond drill holes. There was very little graphite in the diabase and none whatever in the vein-filling. The accompanying plan and section depicts the position of the work done. The graphite noted on this drawing was in traces only; in the old workings the graphite occurred in considerable quantities. We ascribe the lack of silver in the veins tested to the comparative absence of graphite in the country rock.

A plan of the new workings is reproduced on the following page.



Silver Islet Mine.

Diamond drill exploratory work at the Fourth Level carried out by the Islet Exploration Company, Limited.

II.—SUDBURY, NORTH SHORE AND MICHIPICOTEN

Gold

Detroit-Goudreau.—Detroit-Goudreau Gold Development Company, Limited, was incorporated on January 11, 1922, with an authorized capital of $2,500,000 divided into shares of $1.00 par value. The company has bought fourteen mining claims in the Goudreau area, giving therefor 1,400,000 shares of stock. The company's prospectus describes these claims as being situated about one and a quarter miles due east of the Murphy discovery.

The head office of the company is in the Royal Bank Building, Windsor, Ont., and the directors are as follows: president, Fred W. Sparling, Detroit, Mich.; vice-president, Robert R. Richards, Detroit; secretary-treasurer, Netter J. Hill, Detroit; Wm. J. Daeschner, Detroit; G. Cosby Geissler, Detroit; Homer M. Howe, Windsor, Ont.; G. Robert Livingstone, Goudreau, Ont.; Adna K. Masters, Detroit; Carl W. Mulcahy, Detroit; H. Coleman Smith, Detroit; Eugene A. Wigren, Detroit. Most of the directors are in the auditing department of the Michigan Central Railroad Company. Charles G. Daimpré is to be in charge of the work on the property.

Goudreau Gold Mines, Limited.—This company was incorporated to work the Murphy and some adjoining claims in the Goudreau area. The capitalization is $2,500,000, divided into shares of $1.00 par value. The directors are: A. R. Porter, Toronto, president; M. P. Van der Voort, Toronto, secretary-treasurer; Clement A. Foster, Toronto, managing director; W. I. Hearst, Toronto; A. V. J. Selkirk, Franz, Ont. The head office is at 312 Temple Building Toronto.

The company owns a group of twelve mining claims, 534 acres in all, situated in the centre of township 28, range 26, district of Algoma. A million and a half shares of stock were given for the original four Murphy claims, leaving one million shares in the treasury. Eight additional claims were purchased later with a relatively small amount of stock and a small cash payment. The mine is approximately one mile south and three miles west of Goudreau station on the Algoma Central and Hudson Bay railway.

The geological conditions in the vicinity of the Murphy vein have been described by A. G. Burrows of this Department.[1]

A five-mile road has been cut from Goudreau station to the property and camps have been built. The main vein has been trenched and two shafts started, both of which were 25 feet deep at the end of the year. No. 1 shaft is in the southeast corner of mining claim A.C. 408 at the point where the vein was first discovered; the vein here has a dip of 65 degrees to the south. No. 2 shaft is also on the vein 500 feet to the west of No. 1, and is vertical.

Arrangements have been made with the Algoma Steel Corporation for a supply of power from the Steep Hill Falls plant on the Magpie river. This will necessitate the construction of about five miles of transmission line.

W. H. Reamsbottom, Goudreau, Ont., is superintendent, and Albert Terrill, mine foreman.

---

[1] Ont. Dept. Mines, Vol. XXX, pt. 4, pp. 39-44.

Goudreau-Superior.—Goudreau-Superior Mining Company, Limited, was incorporated in Ontario on January 31, 1922, with an authorized capital of $1,500,000 in shares of $1.00 par value. For a consideration of 800,000 shares of the stock and the sum of $10,750, the company bought a block of six mining claims. The company's prospectus describes this block as lying directly west of the properties of the Detroit-Goudreau Gold Development Company, Limited, and the Rand Consolidated Mines, Limited, and adjoining the property of Goudreau Gold Mines, Limited on the east and south.

The directors all live in Detroit, Mich., and are as follows: Netter J. Hill, president; Edward Leszczynski, vice-president; Fred W. Sparling, secretary-treasurer; Berton A. Aikens; John J. Danhof, Jr.; Clarence H. Ladd; Adna K. Masters; Edward M. Pennell; Robert R. Richards; Joseph T. Sullivan; Hugo Zander. Charles G. Daimpré is to be in charge of the prospecting of the claims. The head office is in the Allen Theatre Building, Windsor, Ont.

Grace.—The Grace gold mine in the Michipicoten area near Wawa lake was pumped out and sampled in June and July, 1921. Horace G. Young was the engineer in charge of the examination.

Kirk Gold.—Kirk Gold Mines, Limited, now has the following directorate: George A. Bull, Brampton, Ont., president; R. B. Burkell, Toronto; C. L. Messecar, Brantford, Ont.; Robert Kennedy, Toronto; E. H. Birkett, Havilah, Ont.; director and manager.

At the Bass Lake property the adit was continued to a distance of 625 feet from the portal. As the vein did not seem to warrant further expenditure, work was stopped at this prospect.

The company has bought the Ophir or Havilah mine, which is in lot 12, concession III, Galbraith township, and has been described in some of the early reports of this Department.[1] No work was done here in 1921, other than pumping out the mine for examination and repairing some of the buildings.

Iron

Goulais River.—In December, 1921, diamond drilling was begun in behalf of Charles R. Sligh, Grand Rapids, Mich., on a property forming part of the Goulais river iron range. The property is twelve miles east of mileage 60 of the Algoma Central and Hudson Bay railway, is in the southwestern part of township 22, range XIII, district of Algoma, and consists of eight mining claims. The drilling, 2,750 feet, was confined to two of these claims, S.S.M. 1,289 and S.S.M. 1,293.

Algoma Steel Corporation.—The Algoma Steel Corporation, a subsidiary of the Lake Superior Corporation, owns the steel plant at Sault Ste. Marie, Ont., and the Magpie iron mine in the Michipicoten district.

The officers of the Algoma Steel Corporation are: president, W. C. Franz; vice-president, James Hawson; general manager, James D. Jones; assistant general superintendent, Joseph W. Wilson; chief engineer, F. Smallwood; works engineer, C. H. Speer; superintendent of blast furnaces, James H. Bell; superintendents of open hearths, A. H. Hugill and J. McDonald; superintendent of bloom and rail mill, O. Davies; superintendent of merchant mill, James Lycett; superintendent of coke plant, William Seymour; mechanical superintendent, Carl Stenbol. The secretary is Alex. Taylor, Traders' Bank Building, Toronto.

---

[1] Ont. Dept. of Mines, Vol. III, pp. 37-45; Vol. IV, p. 206, etc.

Magpie.—On March 8, 1921, mining and roasting was stopped at the Magpie mine, and about a month later the mine workings were allowed to fill with water.

When the mine shut down, drifting had been carried on the fifth (the lowest) level 335 feet west of the station and 350 feet east. The ore on this level is of good grade, and fortunately the "mica dyke," which entered the ore body above the third level and has been a source of trouble in some of the stopes, seems to disappear a short distance above the fifth level. On the fifth level to east of the shaft most of the ore body has been developed and part of it has been stoped; to the west of the shaft No. 14 stope has been partly developed, but the diabase dyke has not yet been reached. Above the fourth level some ore remains in stopes 10 and 11 west of the shaft.

The production of roasted ore for the year was 42,198 (short) tons, and shipments totalled 58,401 tons.

George R. McLaren, Magpie Mine, Ont., was superintendent and Robert P. Welden, assistant superintendent. George S. Cowie, Sault Ste. Marie, Ont., is secretary of the Mines Department of the Algoma Steel Corporation, which owns the Magpie.

Mason-Wilcox.—For the past two years a syndicate of residents of Sault Ste. Marie, Ont., has been prospecting some iron claims a mile southeast of Northland station on the Algoma Central and Hudson Bay railway. In the autumn of 1921, a diamond-drill hole was put down near the southwest corner of the northwest quarter, south half, lot 2, concession II, township of Deroche. The property was not visited by the writer, but a reliable informant described the prospect as follows: At the southwest corner of the lot-fraction mentioned above a diabase dyke, 200 to 250 feet wide, cuts the granite in a northwesterly direction, and, on the south contact of the diabase with the granite, several pockets of hematite are exposed.

Moose Mountain.—The mine, concentrator, and agglomerating plant of Moose Mountain, Limited, at Sellwood, Ont., have been closed down since November, 1920, and only some repairing and experimental work were undertaken in 1921, 79 tons of briquettes were shipped during the year.

A. J. Anderson resigned as manager in November, 1921, since which time C. M. Tolman, the company's electrician, has been temporarily in charge.

Copper

Algomont.—Algomont Mines, Limited, was incorporated in 1920, with an authorized capital of $4,000,000 divided into shares of $1.00 par value each. Two million shares of the stock were paid to a syndicate for the mining lands now held by the company. These lands consist of 805 acres and are known as the Asam and McPhee properties. The Asam property consists of 485 acres subdivided as follows: the south half of lot 1, concession VI, and the north half of lot 1, concession V, Plummer township, and the southwest quarter of section 6, Rose township. The McPhee property covers 320 acres and comprises the southeast quarter of section 6, and the southwest quarter of section 5, Rose township.

The company began work in April, 1921, and, after building camps and completing one and a quarter miles of wagon road, bought and erected the following machinery: two 50 h.p. locomotive-type boilers, a Rand compressor with 16-inch by 24-inch cylinders, and a 6-inch by 8-inch Jenckes hoisting engine.

The vein on which work is being done is the "Asam" vein in the southwest quarter of section 6, Rose township; it strikes east and west, is in diabase, and consists of quartz, ankerite and copper pyrites. East of the shaft the vein is exposed in two places: at 140 feet from the shaft it is from two feet six inches to three feet wide; at 195 feet it is two feet wide and at this latter point ankerite is the predominating mineral. From about 600 to 700 feet west of the shaft what is probably the same vein is exposed and several test pits have been sunk; the width of the vein in these pits varies from three feet six inches to six feet. On July 20, 1921, a shaft was started, and on January 31, 1922, it measured 200 feet; this shaft follows the vein which at this point dips to the north at about 75 degrees. In the shaft the vein has an average width of four feet.

There is also a shaft, said to measure 6 feet by 6 feet by 60 feet in depth, on No. 1 vein of the McPhee property in the southeast quarter of section 6, Rose township, but no work has been done at this point by the present owners.

The directors of the company are: Charles N. Haldenby, president, Toronto; John Black, vice-president, Toronto; Dr. A. Moir, Peterborough, Ont.; Richard B. Rogers, Peterborough, Ont.; E. R. Wilson, Peterborough, Ont. The secretary-treasurer is Ziba Gallagher of Toronto, and the company office is in the Bradburn building, Peterborough, Ont.

John A. MacDonald was superintendent until September 1921, when he resigned and was succeeded by George Johnson. About 26 men are employed. The postal address of the mine is Rydal Bank, Ont.

Jewel.—The Jewel Gold and Copper Mining Company, Limited, was incorporated on March 11, 1919, with a capital of $300,000. The capital stock was increased on April 4, 1921, to $1,000,000. The company was formed to work some veins reported to contain gold and copper and situated in lots 11 and 12, concession I, Shakespeare township, about two miles northwest of Webbwood. The company did a little prospecting on the property in the spring of 1921, stopping work on June 15.

The head office of the company is at 67 Richmond Street West, Toronto, and the officers are: president, Joseph H. Vanderlip; secretary-treasurer, James M. Armstrong; general manager, Wm. J. Hands; directors, Wm. J. Hands, Wm. H. Moody, Stephen G. Thompson, Francis E. Cope, all of Toronto.

Nickel and Copper

Owing to the large stocks of refined nickel on hand, only 262,593 tons of nickel-copper ore were shipped from the mines of the Sudbury district to the smelters in 1921; this is the lowest output recorded since 1903. The lack of demand for nickel resulted in the cessation of all work by the British America Nickel Corporation in February and by the International Nickel Company in August. The Mond Nickel Company succeeded in keeping all its mines operating on a small scale and one blast furnace running at capacity.

Wages were twice reduced and at the end of the year the prevailing rates in the district were approximately, miners $4.20 per day, trammers $3.70 per day, and for unskilled surface labour at the mines and smelters from 30 to 34 cents an hour.

British America Nickel Corporation, Limited

Owing to the lack of demand for nickel the British America Nickel Corporation, Limited, was compelled to close down its mine and smelter at Nickelton on February 26, 1921, and its refinery at Deschesnes, Que., a month or two later.

During the year the financial condition of the corporation became such as to render a reorganization necessary. This has been effected and the securities issued now consist of $20,000,000 common stock, $6,000,000 first income bonds, $6,000,000 "A" income bonds, and $12,500,000 "B" income bonds.

The directors are now as follows: Hon. E. N. Rhodes, Ottawa, president and managing director; Captain D. Vogt, Kristianssand, Norway, vice-president and managing director of the corporation's European office; Victor Hybinette, Wilmington, Del., vice-president; A. Gronningsaeter, Ottawa, Ont., technical director; S. M. Brown, Ottawa, Ont., secretary-treasurer; The Rt. Hon. Sir Robert Borden, Ottawa; Sir U. J. R. Borresen, Kristiana, Norway; Sir Eric Hambro, London, Eng.; E. A. Cappelen Smith, New York, N.Y.; J. Fred Booth, Ottawa, Ont.; S. Giertsen, Kristianssand, Norway; Oscar Jebsen, Kristianssand, Norway; P. C. Stevenson, Ottawa, Ont.; E. R. Wood, Toronto, Ont.

Nickelton Smelter.—One of the two blast frunaces at the British America Nickel Corporation's smelter at Nickelton was kept in blast until the shut-down on February 26, 1921; since this date the plant has been idle.

At the end of the year the following members of the operating staff were still at the smelter: E. J. Carlyle, manager; Oliver E. Jager, superintendent; blast furnace superintendent, T. W. Cavers; converter superintendent, B. C. Tomlinson.

Murray Mine.—Up to February 26, 1921, 400 men were employed at the Murray mine; after this only 28 men were retained to sink a winze preparatory to shaft-raising. This winze was sunk from the 800-foot level, where a hoisting engine was placed, to 20 feet below the 1,300-foot level. A crosscut was started from the winze toward the shaft on the 1,300-foot level, but had not been completed when all work was stopped at the end of October.

Ernest Hibbert is manager of mines and H. L. Roscoe is superintendent.

International Nickel Company of Canada, Limited

The International Nickel Company of Canada, Limited, owns and operates mines and a smelter in the Sudbury district and a nickel-copper refinery at Port Colborne, Ont. The officers are: John L. Agnew, Copper Cliff, president; F. S. Jordan, New York, vice-president; Britton Osler, Toronto; secretary; directors, Robert C. Stanley, New York City; Alfred Jaretzki, New York City; James L. Ashley, New York City; John L. Agnew, Copper Cliff; John More, Port Colborne, Ont.; W. B. Lawson, New York City; F. S. Jordan, New York City; Britton Osler, Toronto.

In 1921 the company had an average of about 675 men employed in the Sudbury district until the Creighton mine and the smelter were closed toward the end of August; since the shut-down about 175 men have been employed on maintenance and repair.

The International Nickel Company owns all the stock of the International Nickel Company of Canada, Limited. The stock of the parent company consists of: common shares (par $25.00)—$50,000,000 authorized, $41,834,600 outstanding; 6 per cent. non-cumulative preferred shares (par $100)—12.000,-000 authorized, $8,912.600 outstanding. The officers of the parent company are: Chairman, Charles Hayden, New York City; president, Robert C. Stanley, New York City; vice-president, secretary and treasurer, James L. Ashley, New York City; comptroller, James W. Beard, New York City; directors, Admiral Willard H. Brownson, Washington, D.C.; W. E. Corey, New York City; Alfred Jaretzki, New York City; Charles Hayden, New York City; William N. Cromwell, New York City; Thomas Morrison, Pittsburgh, Pa.; Seward Prosser, Englewood, N.J.; Robert C. Stanley, New York City; William T. Graham, Greenwich, Conn.; W. W. Mein, New York City; James L. Ashley, New York City; Britton Osler, Toronto; John L. Agnew, Copper Cliff, Ont. The general offices are at Bayonne, New Jersey, and the executive and financial offices at 67 Wall Street, New York.

The officers residing in Copper Cliff, in addition to those mentioned elsewhere in this report, are: president, John L. Agnew; general superintendent, John C. Nichols; superintendent of mines, E. T. Corkill; master mechanic of mines, David Butchart; electrical superintendent, J. B. McCarthy; transportation superintendent, G. A. Sprecher; safety engineer, William O. Tower; works auditor, F. C. Allgeier.

The following information is abstracted from the twentieth annual report of the parent company and covers the fiscal year ending March 31, 1922:

> The general depression existing in the metal industry since 1920 became more acute during the twelve months covered by this report and seriously affected your company's business. The demand for the company's product decreased to such an extent that the total sales were less than during any similar period since 1904. Our nickel sales fell off sixty per cent. from the previous year and monel metal sales, though relatively better, decreased thirty-three per cent. This condition called for drastic curtailment and economies.
>
> During August, 1921, all mining and smelting operations were suspended, and the refineries at Port Colborne and Bayonne were practically closed. The total force of employees was reduced to a number sufficient to maintain your plants in good condition and to form the nucleus of an organization which could, when required, promptly and efficiently resume operations. Wages and salaries of all those remaining in the organization were cut substantially.
>
> With a view to future economy of production it was decided to close permanently the Orford Works, Bayonne, and concentrate all nickel refining operations at the Port Colborne, Ontario, refinery, and all operations in connection with rolling monel metal at the company's new plant at Hantington, West Virginia.
>
> The Monel Metal Products Corporation at Bayonne, all of whose stock was owned by your company, has been dissolved and merged with The International Nickel Company. This Bayonne plant will continue to operate as a foundry and warehouse.
>
> During the year rapid progress was made in the construction of the company's new monel metal rolling-mill at Huntington, West Virginia. These works will be ready for operation during the summer of 1922. The total cost, including equipment on hand, is estimated at $3,400,000 of which $2,935,000 has been expended to May 1, 1922.

The consolidated general balance sheet and profit and loss account of the company and its subsidiaries show the company to be in a sound financial condition.

The operating profit for the year was $83,604.34. After providing $437,720.57 for depreciation and depletion and $428,630.70 for expense and maintenance of shut-down mines and plants, the loss for the year was $797,746.93. This loss, plus adjustment of inventories, etc., of $537,833.89, and the payment of the preferred dividend result in a total debit to the surplus account of $1,870,336.82. Inventories now amount to $9,340,589.86 as compared with $11,891,078.23 a year ago.

There was written off the property account for dismantlement $286,575.48, which amount was charged to depreciation of plant reserve account.

Four dividends of 1½ per cent each on the preferred stock of the company have been paid during the fiscal year. The net earnings for the year of the International Nickel Company of New Jersey, inclusive of dividends received from its subsidiaries, were in excess of the amount so distributed. No dividends were paid on the common stock.

The company's business during the first three months of 1922 indicates general improvement in the nickel industry. Monthly sales increased and inquiries for various products became more numerous. Foreign business is slowly becoming stabilized and further improvement is quite evident. Stocks of finished metals have been liquidated to such an extent that the Port Colborne refinery was started on May 1, 1922, and the mine and smelter at Copper Cliff will be started not later than Sept. 1, 1922.

During the year a department was organized to develop new uses for nickel and monel metal, and to extend their known uses. The activity of the development department, coupled with well-directed sales effort, should provide for the new rolling mill profitable tonnage in both rolled nickel and monel metal. It is the belief of the management that a demand for finished nickel in the form of sheets, rods and wire can be created which will offset tonnage previously sold for armament uses.

The number of stockholders increased during the fiscal year from 16,206 to 17,714.

Copper Cliff Smelter.—One, and for a short time two, of the furnaces at Copper Cliff were in operation until the plant was shut down at the end of August. The wedge and reverberatory furnaces have been idle since January 14, 1921.

The officers at the smelter are: superintendent, William Kent; assistant superintendent, Donald MacCaskill; metallurgist, James W. Rawlins; master mechanic, George R. Craig; blast furnace foreman, Peter McDonald; converter foreman, Frank Taylor; reverberatory foreman, Joseph K. Workman.

Creighton Mine.—The Creighton mine was worked on a small scale until August 26, 1921, when all mining was stopped and only a few men were retained on pumping and maintenance. The number of employees varied from 220 in January to 127 in August. Shipments of ore aggregated 51,382 tons for the year. The main shaft remains as at the close of last year, but is now connected with the bottom of No. 10 hanging-wall winze by means of a crosscut on the 30th level.

The staff at the mine includes: superintendent, George A. Morrison; assistant superintendent, W. J. Rolfe; mine foremen, K. C. Browne and Charles Collins; master mechanic, John Symons; electrician, Everett Gillespie.

Dill Quarry.—Dill quarry at Quartz, Ont., was worked during the months of June and July with a force of 45 men. Shipments of quartz to Copper Cliff smelter totalled 23,148 tons. Walter Blackwell was superintendent.

Mond Nickel Company, Limited

The Mond Nickel Company now has the following directorate: Robert L. Mond (chairman), C. V. Corless, LL.D., Viscount Erleigh, Sir E. J. Griffith, Sir Robert A. Hadfield, Dr. Carl Langer, Robert Mathias, Emile S. Mond, S. W. A. Noble, Sir Byron Edmund Walker. The secretary is D. Owen Evans, 39 Victoria Street, London, S.W., England.

The Canadian staff of the company, exclusive of those mentioned under the several properties, is as follows: Dr. C. V. Corless, manager; Oliver Hall, superintendent of mines; John F. Robertson, superintendent of reduction works; W. H. Soule, electrical superintendent; W. L. Dethloff, chief engineer; L. J. Ingolfsrud, assistant chief engineer; T. M. Paris, chief chemist; W. A. MacDonell, cashier; Frank Simms, purchasing agent. All reside at Coniston, Ont.

Coniston Smelter.—In 1921, as in the previous year, one furnace and one converter were kept in blast at the Mond Nickel Company's smelter.

The officers are: E. T. Austin, superintendent; K. S. Clarke, superintendent of sintering and flotation plants; John Grigg, master mechanic.

Coniston Quarry.—During the latter part of the year when the stockpile of siliceous ore from Bruce was nearing depletion, the Mond Nickel Company opened a quarry half a mile southwest of the smelter. The rock here is a quartzite and is being used for flux at the smelter.

Bruce.—In February, 1921, the Mond Nickel Company stopped all work at the Bruce copper mines. A total of 5,439 tons of siliceous copper ore was shipped from Bruce to Coniston smelter during the year.

Garson.—Garson mine shipped 41,658 tons of ore in 1921. Most of this came from the stopes between the fourth and sixth levels and a small quantity was obtained from between the third and fourth. About 70 men were employed.

Pump stations were cut on the 600 and 1,000-foot levels and a sump cut on the latter. A Blake and Knowles double-acting plunger pump, 12 inches by 4 inches by 12 inches stroke, was set up on the sixth level and now pumps the water to the surface. A similar pump will be put on the tenth level to pump to the sixth.

Capt. A. L. Sharp, Garson, Ont., is superintendent, and Chas. Caesar and Alex. Pollock, mine foremen.

Levack.—The ore shipped from the Levack mine in 1920, 42,813 tons, was all obtained from Nos. 34 and 54 stopes which are east of the shaft and between the second and fifth levels. Frank J. Eager, Levack, Ont., is superintendent; J. G. Harris was mine foreman until April when he resigned and was succeeded by William Shovel; William J. Serpell is master mechanic. The force consisted of 70 men of whom 35 were underground.

Victoria.—During 1921 22,684 tons of ore was shipped from this mine; this ore was stoped from the following parts of the mine: stope between the 1st and 3rd levels east of the shaft; 15th and 16th level floor pillars; stope between the 16th and 17th levels, finishing this stope; stope between the 17th and 18th levels. No development work was done. The working force numbered about 68.

W. J. Mumford, Mond, Ont., is superintendent.

Worthington.—Worthington mine shipments for 1921 totalled 28,289 short tons and the working force average about 65 men. Stoping was continued between the second and fifth levels, but no development work was undertaken. A. D. Carmichael, Worthington, Ont., is superintendent, and William McKerrow is mine foreman.

Iron Pyrites

Rand Consolidated.—Rand Consolidated Mines, Limited, has not worked its claims near Goudreau, Ont., since June, 1920, but early in 1922 stock in this company was again being offered for sale by Jackson and Jackson of Buffalo, N.Y.

The capitalization of the company is $5,000,000 divided into shares of $1.00 par value, and 4,100,000 shares have been issued. The directors are:—president, E. N. Ohl, Pittsburgh, Pa.; vice-president and treasurer, F. W. Powers, Pittsburg; Judge Charles A. Pooley, Buffalo, N.Y.; Dan Clemson, Pittsburgh; John M. Shaw, Indianapolis: Frank L. Danforth, Buffalo; Albert H. Jackson, Buffalo.

Miscellaneous

Gros Cap Mining and Exploration Company, Limited.—This company, which was incorporated on October 8, 1919, with a capital of $100,000, owns mining claims S.S.M. 2344 and S.S.M. 2345 and has an option on the south half of the northeast quarter of section 31 in the township of Prince; these holdings are situated at Gros Cap on the St. Mary's river about 12½ miles from Sault Ste Marie, Ont. The company has as yet done but little work.

The head office is at 270 Queen Street, Sault Ste Marie, Ont., and the directors are:—president, J. G. Dycie, Sault Ste Marie, Ont.; vice-president, William D. Clarke, Sault Ste Marie, Mich.; secretary, Florence M. Bonnin, 58 Pim Street, Sault Ste Marie, Ont.; S. Lightfoot, James C. Cheyne, and Robert McMann, all of Sault Ste Marie, Mich.

Shoefelt.—It was reported in September that a silver claim was being prospected near McLennan, Ont., not far from the Soo branch of the Canadian Pacific railway. The writer, therefore, visited the scene of the reported discovery on September 7, On land owned by Jacob Shoefelt in the north half of lot 4, concession II, township of Tarbutt, four men were sinking a prospect pit under the supervision of W. H. Todd of Welland. This pit, which was started some years ago, was 12 feet deep at the time of examination. It was in diabase and a few bunches of calcite carrying a little chalcopyrite had been encountered, but there was no vein visible in the pit at the time of inspection.

III.—DISTRICT OF TIMISKAMING

Gold

Boston Creek, Larder Lake, etc.

Miller-Independence.—Miller Independence Mines, Limited, had 25 men employed at its property in Pacaud township during the first quarter of the year. The force was then cut to 15 men and the work confined to cutting diamond-drill stations and diamond-drilling on the 500-foot level. A total of 1,600 feet of drifting and crosscutting has been done on this level.

W. E. Simpson, Boston Creek, Ont., is manager.

Canadian Associated Goldfields, Limited.—This company now controls Associated Goldfields Mining Company, Limited. The capitalization of the new company is $30,000,000, as compared with $5,000,000 in the old one. Four shares of the new stock were issued to shareholders in exchange for one of the old. The directorate remains as stated in the Thirtieth Annual Report of this Department.

In 1921 the company did the following work at the properties in the Larder Lake area:

At the Harris-Maxwell ("Block B"), diamond-drilling totalling 3,918 feet.

At the Kerr-Addison the 3-compartment shaft was sunk to 320 feet and stations were cut at 175 and 300 feet. Station-cutting amounted to 6,852 cubic feet; excavation for sumps, 1,089 cubic feet; and excavation for diamond-drill stations, 1,642 cubic feet. Between June 1 and October 1, 1921, 775 feet of crosscutting and 310 feet of drifting were completed. This was divided between the two levels as follows: on the 175-foot, 257 feet of crosscutting and 124 feet of drifting; on the 300-foot, 518 feet of crosscutting and 186 feet of drifting. Channel samples were cut in all the crosscuts and drifts as a check on the assays obtained during the previous year from diamond-drill cores. In connection with the prospecting of this property, two dwelling-houses were built on the adjoining Reddick claim, and a smithy, a pipefitting building, and a change house at the Kerr-Addison shaft. The Kerr-Addison was shut down in the last quarter of the year.

In September the company acquired the Costello property, adjoining the claim being tested by the Crown Reserve Mining Company, and built the following: a powerhouse, 18 feet by 50 feet, a 35-foot headframe, a blacksmith shop, a pump house, and a transformer house. The principal machines installed are a 680-cubic-foot Sullivan air compressor, driven by a 150-horse-power motor, and an electrically driven hoist; the latter was brought from the Harris-Maxwell. A 2-compartment shaft, begun November 1, was sunk to 118 feet. A level was established at 110 feet, and on this 100 feet of crosscutting and 20 feet of drifting had been completed at the end of the year. This crosscut passed through a few feet of gold-bearing porphyry. There was also 966 feet of diamond-drilling done on this property.

The company employed an average of 65 men during the year. George Gray was manager during the greater part of 1921 and the first quarter of 1922.

Argonaut.—Argonaut Gold, Limited, has a capitalization of $3,000,000 in shares of $1.00 par value. The company operates under a federal charter and has the following officers:—president, J. H. Rainville; vice-president, F. A. Labelle; directors, Lieut.-Col. Stark, A. Raymond, L. Peddy, and Wilfred Duguette; all of these officers live in Montreal. L. J. Marchand, 145 St. James Street, Montreal is secretary-treasurer, and J. W. Morrison, Dane, Ont., manager.

Mining was resumed on April 4, but the burning of the mill on April 29 necessitated the stoppage of underground work for six weeks while a new transformer house was being built and two 100-kilowatt transformers put in commission. The development work completed during the year consisted of 1,000 feet of drifting and 545 feet of crosscutting; nearly all of this was done on the 350-foot level. An average of 30 men was employed.

The shaft is now being continued from a depth of 380 feet to 500 feet.

Blanche Bay.—The Blanche Bay Syndicate has an office at 152 Livingston Avenue, Buffalo, N.Y., and consists of the following:—Dr. Baker, E. L. Moses, John Shaff, Henry Shaff, and George Walker. The syndicate owns claims L. 6973, L. 6974, and L. 8218 in Grenfell township near Kenogami station and in October and November sank a 22-foot shaft on one of them. Richard Haggerty was in charge.

Blue Quartz.—Blue Quartz Gold Mines, Limited, was incorporated in 1921 to acquire the property at Painkiller lake formerly worked by Cartwright Gold Fields, Limited. The new company has a capitalization of $3,000,000, and the officers are as follows:—H. C. Crow, Toronto, president; C. H. Taylor, Toronto, vice-president; J. F. Loudon, Toronto, secretary-treasurer; J. J. Hollinger, Matheson, Ont., manager. The head office is at 184 Sunnyside Avenue, Toronto.

In 1921 five men were employed at trenching and sinking pits, but in January, 1922, mining was begun with a force of sixteen men. A 100-foot shaft was sunk on one of the claims in 1915.

Crown Reserve.—The Crown Reserve Mining Company, Limited, began trenching in June on a group of claims in McVittie township about a mile and a half north of Larder Lake. This group consists of mining claims L.S. 191, L. 9032, L. 8713 and L. 8841. The trenches were from 40 to 120 feet in length. Those on the first two claims were timbered trenches with a depth varying from 12 to 20 feet; the third one of these trenches was lost by caving. A total of 1,146 feet of diamond-drilling was also done before the property closed down for the winter. H. J. Stewart was manager and about 15 men were employed.

Golden Summit.—The Golden Summit Mining Company, Limited, incorporated October 16, 1919, with a capital of $2,500,000, owns the Jensen farm, which is in the north half of lot 6, concession I, Maisonville township. J. T. Kerr, Windsor, Ont., is president and general manager, and the head office is in the Heintzman Building, Windsor.

In 1921 the company did a small amount of work, deepening a shaft to 27 feet.

Lightning River.—Lightning River Gold Mines, Limited, was incorporated on March 26, 1920, under the laws of Ontario and has an authorized capitalization of $3,000,000, divided into shares of $1.00 par value. The head office is in Guelph, Ont., and the directors are:—William J. Lucy, Haileybury, Ont., president and general manager; J. W. Morrison, Dane, Ont., first vice-president and consulting engineer; William M. Cochenour, Haileybury, Ont.. second vice-president; Thomas McCallum, Montreal, Que.; Dr. R. Lucy, Guelph, Ont.; R. A. Treleaven, Palmerston, Ont.; Udney Richardson, Elora, Ont., secretary and treasurer.

The company is interested in 24 mining claims having a total area of 1.150 acres. All are in the Larder Lake Mining Division, twelve claims in Holloway township, two in Harker township and the remainder in the townships of Maisonville and Egan. The claims in Holloway and Harker townships are in the Lightning river area, twelve miles south of Upper Abitibi lake; the Maisonville claims are two miles from Sesekinika station: and the Egan claims are southwest of Matheson. The company has also acquired the Watabeag river waterpower in Currie township, three miles from the Egan township claims.

In December the Company commenced work on the Harker-township claims, Nos. 7247 (Cochenour) and 7463, and let a contract for the sinking of a two-compartment shaft to the depth of 50 feet.

Skead Gold.—The Skead Gold Mines, Limited operated until December 8, 1921. A dozen men were employed in winter and six in summer with M. L. Bouzan as superintendent.

Two shafts, each 50 feet in depth, and one 18 feet were sunk on lot 29 near Skiddoo lake. On lot 30, twenty-two test pits were sunk from 5 to 18 feet in depth. On the group of claims west of St. Anthony lake three test pits were sunk 8, 15, and 22 feet deep, and on the group of claims east of St. Anthony lake 14 test pits were sunk varying from 8 to 20 feet deep.

Porcupine

Beaumont.—The Beaumont Gold Mines, Limited, has the following officers:—R. T. Jeffrey, president; L. G. Harris, managing director, Royal Bank Building, Toronto; S. H. Allen, manager, South Porcupine. The property of this company is in concession VI, Tisdale township.

In 1921 the shaft was sunk from a depth of 54 feet to 320 feet, and levels established at 150 and 300 feet. Lateral work consisted of 750 feet of crosscutting and 47 feet of drifting. After mining was stopped in the autumn, 3,000 feet of diamond-drilling was done.

A transformer house, an assay office, and a stable were added to the company's buildings. Transforming equipment and a 10-inch by 12-inch hoist were obtained from the Dome Lake mine.

Big Dyke.—The Big Dyke Gold Mines, Limited, had three men employed during the summer and drove an adit 115 feet in length. The property of this company is in Ogden township, half a mile north of the Hayden mine.

Dome.—The authorized capital of the Dome Mines Company, Limited, has been reduced from $5.000,000, to $4,500,000, (as at March 31, 1922) by the payment to shareholders of $1.00 per share. Of the capital stock, $4,260,879.00 has been issued; $29,124.00 has been allotted but is not issued; $209,997.00 remains in the treasury.

The executive officers of the Company are: Jules S. Bache, New York City, president and treasurer; W. S. Edwards, Chicago, first vice-president; H. P. DePencier, South Porcupine, second vice-president and general manager; Morton F. Stern, New York City, third vice-president; Alex. Fasken, Toronto, secretary; C. W. Dowsett, South Porcupine, general superintendent. The directors are: Jules S. Bache, New York City: W. S. Edwards, Chicago; Alex. Fasken, Toronto; G. C. Miller, Buffalo, N.Y.; T. R. Finucane, Rochester, N.Y.; Howard Poillon, New York City: Frederick G. Corning, New York City; Morton F. Stern, New York City; The head office of the Company is at 36 Toronto Street, Toronto, and the executive and financial office at 42 Broadway, New York City.

The following information is an abstract from the eleventh annual report of the Company covering the year ending March 31, 1922:

> Four dividends of 25 cents per share were declared during the year, the last, No. 18—being payable April 20, 1922. The net excess of current assets over current liabilities amounts to $1,758,165.00.
>
> Stoping and development have been carried on from the fifth to the tenth levels and in addition the main shaft has been sunk 263.5 feet to a point 58.5 feet below the twelfth level. Sinking is being continued and the shaft will be below the thirteenth level in May, 1922. Development work has been started on the eleventh level.

The improvement in labour and operating conditions has permitted an increase in the broken ore reserve amounting to about 70,000 tons, the broken ore reserve now standing at 275,000 tons. This result compares very favourably with last year's operating when the broken ore reserve was depleted by 50,000 tons. The cost of breaking this additional tonnage is included in the operating cost, and has to be taken into account when considering efficiency and costs. It is estimated that to obtain a normal operation and maximum efficiency we should have at least 350,000 tons in the broken ore reserve, and it is expected that this position will be reached before the end of the present year.

The results of the development work during the year were very satisfactory, more particularly on the eighth level to the west and on the tenth level to the west. Diamond-drill holes have shown that this ore body continues to the twelfth level, which is 300 feet below the tenth.

The only work done in Dome Extension ground during the year was a small amount of stoping in the sixth level ore body; from this stope 6,510 tons, averaging $4.71 per ton were drawn. It is expected that important ore bodies will be developed in Dome Extension on the eleventh and twelfth levels during the coming year.

The expenditure on mining was $556,299.05 or $1.545 per ton milled as against $1.256 per ton milled during the last year. The increase is due to the fact that 70,000 tons more was broken than was milled, as against 50,000 tons less broken than milled in the 1920-21 year. There has also been a much greater area of stope sill cut during the past year.

The expenditure on development was $404,171.27 or $1.123 per ton milled; this includes 263.5 feet of shaft sinking in No. 3 shaft. The heavy development expenditure was largely necessitated by the fact that the more important ore bodies are situated 450 feet to 900 feet from the shaft, thus requiring long drifts and crosscuts to reach the zones to be prospected.

The following table gives particulars of the development work:

Level	Shafts and Winzes	Drifts	Crosscuts	Crosscuts Slabbing	Raises	Raise Slabbing	Box Holes	Stations and Miscell.	Total	Diamond Drilling
3rd	......	57	......	......	......	......	40	......	97	532.33
5th	......	39	167	32	316	......	92	......	646	1,014.00
6th	......	11	21	3	20	......	86	......	141	1,097.91
7th	......	808	51	98	567	153	330	......	2,007	3,542.00
8th	......	1,050	740	251	438	36	489	40	3,040	3,101.07
9th	......	1,167	416	67	15	......	4	......	1,669	1,503.00
10th	156	928	731	129	920	25	725	32	3,646	6,716.33
11th	196.5	415	25	10	......	......	......	195	841.5	......
12th	67	17	......	......	......	......	......	88	172	......
Totals	419.5	4,492	2,151	590	2,276	214	1,766	355	12,263.5	17,506.64

Waste hoisted, 45,036 tons.

The ore bodies opened up during the year, as formerly, have proven so irregular in form and mineral content that no satisfactory estimate can be based on the exposures in drifts and crosscuts. Only by experience in actual stoping operations can we form any definite idea of what tonnage may reasonably be expected from a given exposure, and the law of averages must be depended upon in the final result.

While production of the last year has been the greatest in the history of the mine by 29 per cent., we are confident that the extensive development policy adopted has been successful in placing an equivalent amount in sight, and we can therefore look forward confidently to similar results from our future operation.

The following are the treatment results from the operation of the mill during the year:—

		per ton	per cent.
Heads, 360,000 tons		$8,203	.....
Amalgamation bullion	$1,622,012 48	4,506	54.924
Cyanidation bullion	1,187,439 90	3,298	40.209
	$2,809,452 38	7,804	95.133

Of the 360,000 tons of ore milled 333,081 tons, averaging $8.65 per ton, came from the stopes and 26,919 tons, averaging $10.16 came from development.

The total milling cost was $445,703.38, or $1.238 per ton treated. The cost for the previous year was at the rate of $1.563 per ton. The following factors were responsible for the reduced cost; the increase in the tonnage milled, the somewhat lower cost of some supplies such as iron and steel, and the reduction in the wage rate. These savings were to some extent offset by the expense incurred by finer grinding and longer treatment of the ore. The extraction was 95.13 per cent. as against 94.728 per cent. for last year. The finer grinding, already referred to, became necessary owing to the rock from some of the ore bodies showing a tendency to give a reduced extraction with ordinary fine grinding. At present the ore is ground so that 92 per cent. passes a 200-mesh screen, a degree of fineness surpassed by only a few mines treating exceedingly rebellious ores. Longer cyanide treatment, as well as finer grinding, has been found necessary, and this is being provided for by the addition of two more Pachuca tanks, which will increase the time of treatment by thirty per cent.

Both the re-grinding tube mills have been equipped with special liners and iron balls to improve the fine grinding of concentrate. Two Pachuca tanks have been in operation since completion early in the year, and two more will be completed and in operation early this year.

Expenditure on increase of plant amounted to $55,969.86, of which $7,048.00 was written off. A third 2,500-cubic-foot Belliss and Morcom compressor has been ordered and will be installed early in the year; this compressor was ordered in 1916, but war conditions prevented shipment. The buildings at Dome Extension have been converted into dwellings, thus providing eight more houses for employees. The new hospital to replace the one burned was completed early in the year.

Operating costs amounted to $4.558 per ton milled, as compared with $4.529 for the previous year. This increase is more than accounted for by the increased expenditure on development work, this expenditure amounting to $1.123 per ton milled, as against $0.925 for the former period. There is also an increase of 70,000 tons in broken ore reserve, as against a reduction of 50,000 tons in the previous year.

An ample supply of labor has been available throughout the year and a reduction of six cents per hour has been made in wage rates.

Goldale.—Goldale Mines, Limited, has bought from The Ontario Porcupine Goldfields Development Company, Limited, the fifty claims formerly owned by Bewick, Moreing and Company: The company has a capital of 3,000,000 shares of $1.00 par value, and 1,751,421 shares have been issued. The directors of the company are as follows:—James Y. Murdoch, Toronto, president; H. W. Knight, Toronto, vice-president; Arthur H. Britton, Toronto, secretary-treasurer; T. H. Rea, New York; and R. V. LeSueur, Sarnia. The head office is at 85 Bay St., Toronto.

In 1921 the work done consisted of trenching, sampling, and the sinking of five diamond-drill holes totalling 2,503 feet.

Kerr Lake Mines, Limited, has bought a large block of the company's treasury stock and in April, 1922, H. A. Kee took charge of the work.

Hayden.—Hayden Gold Mines, Limited, had a capitalization of $2,000,000, but at the last annual meeting a reorganization was effected and the capitalization increased to $5,000,000. W. H. Hayden is president and general manager; W. H. Hills, vice-president; and Willis M. Spaulding, secretary and treasurer. The head office of the company is at 509 Brisbane Building, Buffalo.

The mine was pumped out in October and mining resumed late in December with a force of twelve men. Thirty feet of drifting was done before the end of the year.

Hollinger.—The Hollinger Consolidated Gold Mines, Limited, has an authorized capital of $25,000,000—5,000,000 shares of $5.00 par value each; 4,920,000 of these shares are outstanding. The officers of the company are: Noah A. Timmins, president; David A. Dunlap, vice-president and treasurer; John B. Holden, secretary; A. F. Brigham, general manager. The directors are: Noah A. Timmins, L. H. Timmins, Jules R. Timmins, and Dr. Wilfred L. McDougald of Montreal; David A. Dunlap and John B. Holden of Toronto. The mines and head office are at Timmins, Ont., and the general office is at 85 Bay Street, Toronto.

The following account of the year's operations is summarized from the eleventh annual report of the company, covering the year ending December 31, 1921:

The yield from 1,072,493 tons milled in 1921 was $10,031,050.57. Total income from all sources was $10,314,515.31. Operating expenses absorbed $5,222,855.69, taxes $429,889.61, depreciation, etc., $634,842.52, making $6,287,587.82 in all, and leaving a net profit of $4,026,927.49; out of the latter $3,198,000.00 was paid in dividends and $828,927.49 added to surplus, which now stands at $3,960,779.50.

Following is a summary of charges per ton of ore milled:—

	Sundries.	Labour.	Stores.	Total.	Per ton milled.
General charges.....	$110,163 71	$228,924 69	$120,739 39	$459,827 79	$0.4287
Mining charges.....	....	1,979,817 73	1,215,026 71	3,194,844 44	2.9789
Milling charges.....	....	500,891 00	1,067,292 46	1,568,183 46	1.4622
Grand Total....	$110,163 71	$2,709,633 42	$2,403,058 56	$5,222,855 69	$4.8698

Expenditure charged to plant account for buildings and equipment during the year was $482,790.79, and the amount written off was $627,488.50. Plant account now shows a total expenditure from 1910 to the end of 1921 of $4,183,256.76 and $2,827,954.47 written off during that period; the present valuation is 32.4 per cent. of the total cost of the plant, as compared with a valuation of 40.5 per cent. at the end of 1920.

The company's property has been augmented by the construction of 150 cottages for employees on the Jerome addition to the town of Timmins. This work involved a further expenditure for clearing the land, the laying of water service and sewers, streets, and electric-light equipment.

At No. 11 shaft a large and well-equipped change house to accommodate 800 miners has been built and put in use; also the old change house at the main shaft has been replaced by one designed to serve 600 miners. These buildings are well-lighted, warm, dry and equipped with individual steel lockers, wash-basins, showers and modern sanitary conveniences. A new building to centralize drill sharpening and tempering has also been completed with facilities for handling 9,000 drills per day.

As to power, the compressor plant now comprises three units of 4,500 and one of 9,100 cubic feet capacity, equal to 22,600 cubic feet of free air per minute. Two of the smaller compressors are so designed that, by making some minor changes, they can be converted into steam engines, and the motors that drive them operated as generators. This arrangement is novel and was adopted to ensure the continuous operation of the cyanidation machinery in the event of breakdowns, but it is not intended that the plant shall function in the reversed condition for a longer time than is necessary to make repairs to the power company's machinery or transmission lines. Notwithstanding this fact, two units were operated continuously from the middle of December, 1920, to April 7, 1921. This provided about 1,200 horsepower which, with the 1,500 kilowatts allotted by the power company, constituted the entire supply of electric power, as compared with 8,100 horsepower used and paid for during the latter part of the year. Work was adjusted to the reduced scale, and costs mounted to a figure never before reached by the Hollinger. From April 7 they declined, and toward the end of the year, as the mill feed increased, were approaching normal, but they are still higher than the figures for the year 1920.

In the mine a new vein was discovered on the 200-foot level; it is numbered 92 and is of good grade and width. The rest of the ore bodies have maintained their value and size.

Drifting and crosscutting was continued throughout the year at such a rate as to provide for the immediate stoping requirements, and maintain the ore reserves at about the same figure as shown in the preceding three years. The policy of the company is to so adjust the development programme that the ore put in sight will, with a safe margin, approximate the tonnage milled. This will continuously tie up $1,750,000 and will ensure a three and a half years' supply of ore at the present rate of milling.

The development work done during the year was as follows:

Level	Shafts	Drifts	Cross Cuts	Raises	Diamond Drilling	Timbering		Excavation
						Shafts	Stopes	
	Feet	Feet	Feet	Feet	Feet	Feet	Feet	Tons
100 feet	......	....	....	....	1,321	....	....	....
200 feet	......	1,690	494	325	6,786	....	333	....
300 feet	......	1,444	244	567	3,557	....	1,210	....
425 feet	......	1,787	1,361	408	6,520	....	1,212	....
550 feet	......	1,820	700	...	5,600	....	1.332	....
675 feet	......	4,884	3,859	...	6,588	....	3,549	....
800 feet	......	4,792	1,467	...	5,661	....	1,348	131
950 feet	......	140	2,341	...	525	....	....	....
1,100 feet	10	204	1,617	337	1,059	....	....	75
1,250 feet	...166	....	800	136	.....	....	....	115
Total....	176	16,761	12,883	1,773	37,617	....	8,984	321

Total, Sinking, Drifting, Cross-Cutting and Raising, 31,593 ft.

Details regarding the broken ore:

Level	Broken Ore in Mine Jan. 1, 1921	Ore Broken During 1921	Ore Removed During 1921	Broken Ore in Mine Dec. 31, 1921
No. 10 Shaft Dump	2,250	....	....	2,250
Above 200 ft. Level	56,096	113,868	108,338	61,626
" 300 ft. Level	34,264	101,449	99,630	36,083
" 425 ft. Level	77,716	182,218	131,143	128,791
" 550 ft. Level	232,908	380,435	470,856	142,487
" 675 ft. Level	660	206,803	136,363	71,100
" 800 ft. Level	91	207,295	119,840	87,546
" 950 ft. Level	....	1,466	1,466	....
" 1,100 ft. Level	....	1.244	1,244	....
" 1,250 ft. Level	....	1,074	1,074	....
Total	403,985	1,195,852	1,069,954	529,883

The ore developed underground as of December 31, 1921, was:

Above 425-foot level—1,408,314 tons valued at $15,012,250
425 to 800-foot level—1,712,571 tons valued at $18,721,478
Below 800-foot level— 281,724 tons valued at $ 2,910,426

A total of 3,402,609 tons valued at $36,644,154

A summary of ore reserves follows:

	Tons	Value per ton	Estimated gross value Dec. 31, 1921.	Estimated gross value Dec. 31, 1920.
Veins over $10.00	1,571,979	$12 80	$20,127,764	$19,825,861
Veins, $10.00 to $8.00	1,653,969	9 15	15,138,440	15,697,762
Veins, $8.00 to $6.00	176,661	7 80	1,377,950	1,072,436
Total ore reserves	3,402,609	10 77	$36,644,154	$36,596,059
Probable ore—				
Veins under $6.00	787,668	5.28	$4,162,833	3,135,731
Surface outcrops	202,640	9 42	1,909,040	1,987,880
Total	4,392,917	$9 72	$42,716,027	$41,719,670

Certain minor changes in the coarse-crushing machinery have resulted in an increase in the tube mill output, and established the capacity of the whole plant at 4,000 tons, or more, per day; this average can be confidently expected for the coming year.

Following is a statement of the milling results:

Tons ore milled	1,072,493
Average value per ton	$ 9 67
Gross value	$10,367,901 07
Deduct loss in tailing	$ 336,850 50
Net value recovered	$10,031,050 57

Average tons per day	2,938 tons
Per cent. of possible time run	78.7
Tons per 24 hours running time	3,733 tons
Stamp duty per 24 hours running time	16.59 tons
Solution precipitated per ton ore	2.08 tons
Value per ton in tailing	$0.31

Cyanide consumed per ton of ore	0.521 lbs.
Zinc consumed per ton of ore	0.209 lbs.
Zinc consumed per ton of solution	0.100 lbs.
Lime consumed per ton of ore	2.406 lbs.
Lead acetate per ton of ore	0.012 lbs.
Average value pregnant solution	$4.48

The average number of men employed during the year has been 1,582, distributed as follows:—

Miners.		Mechanics.		General.		Total.	
Exploration	11	Operation	72	Mill & refinery	182	Miners	1,003
Development	203	Maintenance	141	Engineering staff	39	Mechanics	218
Production	789	Construction	5	Clerical staff	29	General	361
				Miscellaneous	111		
	31,00		218		361		1,528

The number of stockholders has increased from 2,800 to nearly 3,500.

McIntyre.—The ninth annual report of McIntyre Porcupine Mines, Limited, covering the fiscal year ending June 30, 1921, is summarized below:—

Brig. Gen. Sir Henry M. Pellatt, C.V.O., has retired from the directorate and has been succeeded by W. J. Sheppard of Waubaushene as vice-president, and by Joseph Errington of San Francisco as director.

Net operating earnings before providing for taxes and depreciation amounted to $815,562.53 and non-operating revenues to $272,951.38 or a total of $1,088,513.91. This is a decrease of $191,718.46 in total earnings from the previous year and is due to a curtailment of work from December 26, 1920, to April 7, 1921, caused by a shortage of power. To guard against a similar shortage, the company has acquired the right to develop Sturgeon Falls on the Mattagami River, thirty miles from the mine. Of the total earnings, $272,983.79 was appropriated as follows:

Reserve for plant depreciation	$207,326 50
Reserve for taxes for the current year	64,525 54
Written off holdings in adjoining mining properties	1,131 75

This left a net profit for the year of $815,530.12.

As in the previous year, three dividends of five per cent. each and aggregating $546,042.45 were paid to the shareholders. The surplus now amounts to $1,646,207.76.

During the year, there was treated 171,916 tons of ore having an average value of $11.67 per ton; this yielded bullion containing 91,330.26 ounces of gold and 19,806.4 ounces of silver, valued at $1,904,326.36; a recovery of $11.08 per ton of ore treated.

The total ore hoisted was 174,030 tons, of which 153,267 tons was obtained from stopes and development headings and the remainder from broken ore reserves. There are now 92,748 tons of ore broken in the stopes.

Following is a summary of ore hoisted:

Level	Tons	Assay value	Total value
600	2,138	$ 7 00	$ 14,966 00
700	1,623	9 25	15,012 75
800	4,433	14 75	65,386 00
1,000	47,731	13 85	661,074 35
1,125	53,022	9 85	522,266 70
1,250	31,356	14 15	443,687 40
1,375	30,565	9 15	279,669 75
1,500	3,162	9 00	28,458 00
	174,030	$11 58	$2,030,520 95

Development work done during the year was confined to the 1125-, 1250-, 1375-, and 1500-foot levels. The carbonaceous schist encountered in the lower levels of the mine occurs in a series of south-dipping thrust faults intersecting No. 5 vein for a distance of 350 feet on the 1250, 420 feet on the 1375 and 435 feet on the 1500. Drifting in this faulted zone opened up sections of No. 5 vein of good stoping width, but, in mining, this ore will be diluted with carbonaceous material requiring special treatment before cyanidation. Considerable development has been carried on to the west and below the carbonaceous zone of the four lower levels, and on each level No. 5 vein has been found to continue below the zone without any marked change of gold content, three stopes now producing ore from this section assay from $13.00 to $16.40.

Below the 1250-foot level the contact between the greenstone-basalt schists and the porphyry, which strikes southwest, flattens out and the area of favorable ore-bearing formation is increased.

The main shaft is being sunk from the 1500-foot level and is now 1610 feet deep. Levels will be opened at 1625, 1750 and 1875 feet. No. 5 shaft is being raised from the 1375 to the 1000, and when completed will be sunk to the 1500-foot level to facilitate the development of the lower levels.

Development and exploration work to 30 June, 1921, are summarized as follows:—

Drifts	41,575.8 ft.
Cross-cuts	15,243.3 “
Raises	6,499.4 “
Winzes	579.7 “
Shafts	5,697.4 “
Stations	1,459.0 “
Sumps	2,542.0 tons
Pockets	3,764.0 “
Total Footage	71,054.6 ft.
Excavations	6,306.0 tons
Diamond Drilling	49,319.0 ft.

The total operating costs per ton milled amounted to $6.3331. Mining costs totalled $3.5711, made up of: breaking and stoping $2.3004, development $1.1728 and exploration $0.0979. The other items are: milling $1.2052, crushing and transportation of ore $0.2317, head office expense $0.4461, mine office expense $0.3592, employees' insurance and welfare, $0.2569, heating and maintenance of buildings, $0.1683, general insurance $0.0866, examination of prospects $0.0080.

The ore reserves are estimated as follows:

	Tons	Assay	Amount
McIntyre claims	224,586	$10 55	$2,366,524 00
McIntyre Extension claims	205,007	10 50	2,153,981 00
Jupiter claim	102,081	7 95	813,275 00
Broken ore reserves in stopes	92,748	11 40	1,058,614 00
	624,422	$10 25	$6,392,394 00

A process has been developed that will satisfactorily treat the ores containing carbonaceous matter without the aid of flotation. After a preliminary treatment in the ball and tube mill circuit, the ore can be safely sent to the cyanide plant without danger of causing a premature precipitation of the gold. The milling capacity of the plant will be increased to 1,000 tons per day by the addition of a 500-ton unit equipped to handle carbonaceous ores.

The mill ran 85.5 per cent of the time, and treated 171,916 tons of ore at a cost of $1.2052 per ton with an extraction of 94.9 per cent.

Northcrown.—The directors of the Northcrown Porcupine Mines, Limited, decided early in the year to develope and diamond-drill the Thompson-Krist section of the property. Up to June 7, 2,000 feet of drifts and crosscuts were driven and 1,500 feet of diamond-drill holes completed. During the remainder of the year only a small crew for pumping and maintenance was employed.

Porcupine Davidson.—Porcupine Davidson Gold Mines, Limited, has succeeded Davidson Consolidated Mines, Limited, as owner of the 420 acres known as the Davidson mine. The price paid for the property was £50,000 cash, £175,000 preferred stock, and £450,000 common stock. The capitalization of the new company is £1,000,000, in shares of five shillings each, and £710,044 has been issued. The directors are: Colonel Robert Starke, Montreal, Que.; H. H. Sutherland, Toronto; Arthur Wilson Filmer, London, Eng.; Sir Archibald Mitchelson, Bart., London, Eng.; The Hon. Inigo Brassey Freeman Thomas, London, Eng.; Robert Fennell, Toronto; J. J. Davis, London, Ont. R. E. Evans, 4 King Edward Hotel, Toronto, is secretary-treasurer.

The mine was pumped out in September, and 45 men, exclusive of ten diamond-drill operators, were employed between October and December 12. The development work done consisted of: 74 feet of crosscutting north and 149 feet west in ore on the 600-foot level; a 49-foot raise, connecting the 600-foot with the 550-foot level, and 100 feet of crosscutting to the south from the top of the raise.

Four thousand feet of diamond-drilling was done from the 600-foot level; this showed commercial ore at a vertical depth of 725 feet. One 600-foot and two 1000-foot holes were drilled from the surface, and two more 1,000 foot holes are being put down to cut the ore at a depth of 1,000 feet; when this drilling is completed, the ore body will have been tested for a length of 1,500 feet.

Porcupine Peninsular.—The Callinan-McKay Exploration Company (A Delaware incorporation) began work in August, under a working option on the properties of the Porcupine Peninsular Gold Mines, Limited, The latter is an Ontario Company with a capital of $1,000,000 and owns Gold island and a portion of the peninsula in Night Hawk lake; the original board of directors consisted of: J. H. Black, C. M. Auer, J. A. McKay, George Grover and Frank Forbusch. On March 24, 1922, Night Hawk Peninsula Mines, Limited, was incorporated with a capital of $5,000,000 and acquired the assets of both the above-mentioned companies together with some additional mining claims. The officers of the new company are: William Thaw, president; J. W. Callinan, vice-president; J. A. McKay, vice-president; Samuel J. Grenet, Treasurer; Sam. Hallis; James R. Dodworth, chairman board of directors. A. R. Globe is manager and from twenty to thirty men are employed.

The property has an area of 266 acres and comprises 7 claims in two groups, namely; Nos. 914 to 919, and P. 7801.

There was an 80-foot shaft on the end of the peninsula. This was deepened by 110 feet and a second level opened at 180 feet. Lateral development in 1921 consisted of 11 feet of crosscut and 29 feet of drift. Subsequent drifting has given very encouraging results, and in the west drift on the 180-foot level a face of 24 feet of $14.00 ore has been opened up.

Porcupine Keora.—Porcupine Keora Mining Company, Limited, had 15 men at work during the first seven months in the year and kept the mine pumped out until October 15, when it was allowed to fill with water.

The development work consisted of 80 or 90 feet of drifting in graphitic ore, 30 feet of drifting on No. 11 vein and 390 feet of crosscutting south on the 245-foot level to cut Nos. 1 and 3 veins. J. C. Waite is manager.

Triplex.—The Triplex Gold Mines, Limited, capitalized at $5,000,000 in shares of $1.00 par value, was formed to work 29 mining claims in Shaw and Langmuir townships. The holdings aggregate 1266 acres and include the Tommy Burns, Cavanagh, Pope, and other claims. The officers are:—Charles B. Post, Worcester, Mass., president; Andrew G. Hildreth, Worecster, Mass., first vice-president; Gordon H. Gauthier, South Porcupine, Ont., second vice-president: Matthew Thomas, South Porcupine, Ont., secretary-treasurer; Charles S. Averill, Worcester, Mass., director; William H. Dalton, Toronto, director; William M. Moore, Toronto, director; Major Duncan B. Harrison, Hotel Bancroft, Worcester, Mass., construction manager and fiscal agent.

The company started work in June on the Burns claims, sank 105 feet of incline shaft, and on the 100-foot level did 30 feet of drifting to the north and 37 feet to the south. The force consisted of 20 men.

Union.—The Union Mining Corporation, Limited, continued to prospect in Whitesides township until December 10, when it was decided to stop work at the property there and exploit the Smith-Labine claims, a 120-acre property near Sesekinika. The company has been changed to a common-law business trust, the Union Gold Mines Trust, with a capital of $2,000,000 in $10.00 shares.

The underground work completed at the Whitesides township prospect consisted of: a 260-foot shaft with levels at 150 and 250 feet; on the 150-foot level, 230 feet of crosscutting and 100 feet of drifting; on the 250-foot, 130 feet of crosscutting. From 25 to 30 men were employed under manager C. T. Denker, Timmins, Ont.

Kirkland Lake

Bidgood.—The Bidgood Gold Mines, Limited, had thirty men employed on its property in Lebel township during the last seven months in the year. George Tough is president, and D. H. Angus, manager.

Development work consisted of drifting on the 300-foot level, mainly on No. 9 vein, sinking the shaft from the 300 to the 400-foot level, and crosscutting on the 400-foot level to cut No. 9 vein. The following summary shows the amount of work accomplished underground during 1921 and to date:—

	1921.	Total.
Drifting	633 feet	1044 feet
Crosscutting	308 feet	657 feet
Shaft sinking	100 feet	417.5 feet
	1041 feet	2118.5 feet

King Kirkland.—The King Kirkland Gold Mines, Limited, has an authorized capital of $2,500,000 of which 1,250,000 shares have been issued, and 1,250,000 remain in the treasury. The board of directors is as follows:—C. F. Jordan, Haileybury, Ont., president and general manager; E. L. Wettlaufer, Toronto, Ont., vice-president; A. B. Crosby, Treasurer; G. A. M. Davidson, secretary, (Clerk of Markham township); George I. Hambly, Toronto, and John Schwartz, Kitchener.

The company owns 7 mining claims, L.8001, L.8002, L.4117, L.4118, L.2292, L.2910, LS.108, in one block of 309 acres in Lebel township east of Gull lake. Twenty men were employed during the summer under the supervision of Ernest Craig. The work done consisted of considerable trenching, the sinking of a 100-foot shaft and a little drifting.

Kirkland Combined.—On December 1, 1921, the Kirkland Combined Mines, Limited, resumed drifting on the 200-foot level. Work was in progress for two months, during which 300 feet were driven and a 600-foot diamond-drill hole put down. Ten men were employed in the mine, five of whom were diamond-drill workmen. A. W. Grierson is superintendent.

Kirkland Lake.—The Kirkland Lake Gold Mining Company, Limited, has a paid-up capital of $2,000,000, the par value of the shares being $1.00.

The directors of the company are:—F. L. Culver, president; W. T. Mason, vice-president; R. Graham, secretary-treasurer; F. L. Lovelace. The head office of the Company is at 810 Lumsden Bldg., Toronto. W. M. Sixt is mine superintendent.

The sixth annual report of the company covers the period for the seven months ending December 31st, 1921. The development work during this period was as follows:—drifting, 1043 feet; crosscutting 163 feet; raising 148 feet; shaft raising 77 feet; shaft sinking 15 feet; diamond-drilling 1,001 feet. The main or central shaft is now at the 700-foot level. The mill treated 25,717 tons of ore from which was recovered $147,654.83 in gold bullion.

Lake Shore.—The Lake Shore Mines, Limited, has a capitalization of 2,000,000 shares of a par value of $1.00. The executive officers are:—Harry Oakes, president and managing director; W. H. Wright, vice-president; J. B. Tyrrell, second vice-president; Dr. W. P. St. Charles, treasurer; Kirkland Securities, Limited, secretary. The directors are Harry Oakes, A. G. Slaght, Dr. W. P. St. Charles, C. E. Wettlaufer, Albert Wende, J. B. Tyrrell, W. H. Wright. R. C. Coffey is mine manager.

For the year ending Nov. 30, 1921, 21,681 tons of ore were milled, from which was recovered in bullion $460,186.37, or $21.22 per ton. A total of 3,188 feet of development work was done during the year and the broken ore in stopes amounts to 28,298 tons. The shaft was sunk to the 600-foot level and No. 1 and No. 2 veins were opened up on this level.

Future plans include enlarging the shaft from the 400-foot level to the surface, sinking to the 800-foot level and increasing the milling capacity.

Three dividends of $40,000 each were paid during the year.

Montreal-Kirkland.—In November, 1921, the Montreal-Kirkland Mines, Limited, began work with a force of eight men on its 200-acre property, which is north of the Ontario-Kirkland mine. The camps were repaired and the following erected: a transmission line, a power house, 24 feet by 36 feet, a 47-foot head frame, a blacksmith shop and a stable. B. G. Killoran was in charge.

The company had a capitalization of $2,500,000. The board of directors is as follows: W. F. Empey, president; John T. Tebbutt, vice-president; A. A. Mack, secretary; Senator N. Curry, Robt. Curry, F. J. Hodgson, J. B. Peloquin, Fred Cooper, T. H. Reider, all of Montreal, and B. G. Killoran of Haileybury. The head office of the company is at 46 Bank of Ottawa Building, Montreal.

A merger with the Ontario-Kirkland Gold Mines, Limited, was effected March 10, 1922. The agreement provides for the formation of a new company known as the Montreal-Ontario Mines, Limited, with a capital of $5,000,000 in shares of $1.00 par value. The Ontario-Kirkland shareholders are to receive 1,500,000 shares in the new company equivalent to their capital stock, and the Montreal-Kirkland shareholders are to receive 1,725,000 shares in the new company, the equivalent to their issued stock. The new company assumes the current liabilities of the Ontario-Kirkland Mines, Limited, amounting to not more than $120,000, and in addition agrees to issue 481,250 shares of stock to provide for the payment of the present outstanding notes of the Ontario-Kirkland company amounting to $173,250.00; it further agrees to issue additional shares at 40 cents to cover the six per cent. interest on these notes.

The officers of the new company are: president, W. F. Empey; vice-president, Frank Huth; secretary-treasurer, A. A. Mack; directors: Albert J. Bolton, Hon. Daniel Curry, Walter E. Hurd, Robert Curry, W. H. Meyer, J. B. Peloquin, John T. Tebbutt.

Ontario-Kirkland.—The Ontario-Kirkland Gold Mines, Limited, operated its property at Kirkland Lake during the year with an average force of about 40 men; the force was increased to 70 men when the mill was put in operation about the end of the year. The company has a capitalization of $1,500,000 in shares of $1.00 par value.

The officers are: Frank Huth, president; Walter E. Hurd, vice-president; Albert J. Bolton, treasurer; W. A. Gordon, secretary; Ralph Hurd, manager.

The development work during the year consisted of 50 feet of crosscut on the 300-foot level, and 1,500 feet of drifts and crosscuts on the 450-foot level. The No. 2 shaft was completed to the 450-foot level by sinking from the surface and raising from the bottom level. Development from the No. 2 shaft consisted of 150 feet of crosscuts and 150 feet of drifts on the 150-foot level.

Stoping was begun in the last quarter of the year, and the No. 317 stope was carried up 40 feet over a length of 125 feet; the No. 302 stope was carried up 30 feet over a length of 175 feet. On the 150-foot level a small stope was carried up 20 feet over a length of 60 feet.

The additions to plant included the construction of a 100-ton mill complete for cyanide treatment; the installation of an additional air compressor of 1046-cubic-feet capacity driven by 170 h.p. motor, and an Ingersoll-Rand double-drum hoist driven by a 50 h.p. motor.

The mill was started in December, but two breakdowns of the hoist caused a month's delay. Between 3,000 and 4,000 tons were milled before the property was closed down, February 18.

Queen-Lebel.—The Queen-Lebel Gold Mines, Limited, has an authorized capital of $2,000,000 in shares of $1.00 par value; 1,000,000 shares have been issued and 1,000,000 remain in the treasury. The board of directors is as follows: G. A. Wanless, president; David Gross, vice-president; V. H. Hattin, secretary; Harry Braniff, treasurer; W. H. Hamblin and William T. Sass, all of Kitchener, Ontario, and E. B. Wood, general manager, Haileybury, Ontario. The head office of the company is at 35 King St. West, Kitchener, Ontario.

The company owns a group of four mining claims south of the east end of Gull Lake in Lebel township. The property contains 136.7 acres.

Trenching began on May 23, 1921, and about 3,000 lineal feet of this work was done during the summer with a force of 10 men. A 60-foot shaft was sunk by hand during the first quarter of 1922.

Camps and a power house were built and the following machinery installed in the spring of 1922: two 50-h.p. boilers, a 420-cubic-foot Ingersoll-Sargeant air compressor and a 7 by 9-inch hoist.

Teck-Hughes.—Teck-Hughes Gold Mines, Limited, operated its property during the year. The board of directors is as follows: Charles L. Denison, president; Albert W. Johnston, vice-president; George C. Miller, secretary; William C. Himrod, treasurer; Robert W. Pomeroy, J. F. Thompson. D. L. H. Forbes, Kirkland Lake, Ont., is general superintendent. An average of 75 men was employed.

The general superintendent's report for the fiscal year ending August 31, 1921, gives the following summary of operations:

During this period 32,634 dry tons of ore were treated from which bullion amounting to $304,792.33, or $9.34 per ton, was recovered. Including exchange, premiums and interest, the gross revenue for the year was $344,806.44, or $10.57 per ton. The total operating cost, including such indirect charges as depreciation on plant, new construction and extraordinary expense, amounted to $291,956.07, or $8.95 per ton, leaving a net revenue of $52,850.37. A detailed analysis of operating costs shows that the total direct operating cost amounted to only $7.01 per ton.

The first, third and fifth levels were extended and the sixth level started. Development work produced 3,935 tons of ore, that was treated in the mill, 587 tons of low grade rock, that was sent to stock piles, and 4,372 tons of waste. The total amount of development work was 1,792.8 lineal feet as detailed in the summary below.

	Winzes	Raises	Drifts	Crosscut	Shaft sinking	Station cutting	Total
At Sept. 1, 1920..........	464.0	595.0	6,074.0	2,993.0	816	109	11,051.0
For fiscal year...........	48.0	237.5	842.5	664.8	....	....	1,792.8
At Sept. 1, 1921..........	512.0	832.5	6,916.5	3,657.8	816	109	12,843.8

At August 31, 1921, ore reserves were estimated to be as follows:

	Tons	Av. Grade	Gross Value
Blocked-out ore	18,100	$11 04	$199,800 00
Broken ore	24,500	8 92	218,500 00
Total fully developed	42,600	$ 9 84	$418,300 00
Partly developed	56,290	$ 8 69	$488,840 00
Total ore reserves	98,890	$ 9 17	$907,140 00

In July, 1921, work was commenced to bring the treatment capacity of the mill up to the estimated capacity of the mine and surface equipment with only slight expenditures on mill, sleeping camp and electric power equipment. This work when completed should appreciably increase the profit to be derived from the known resources of the mine, and ultimately enable the profitable mining and treatment of blocks of ground in the mine that would otherwise have to be abandoned as unprofitable.

A supplementary report of the general superintendent for the last four months of the calendar year shows that the net profit per month from September 1 has been upwards of $10,000; also that the development on the sixth level has been so satisfactory that the treatment of 2,900 tons of ore during the month of December gave a gross return of about $46,000, which should yield about $25,000 net profit. Not only has some very satisfactory ore been encountered, but the work has developed some high-grade ore shoots, especially towards the eastern end of No. 3 vein at the 600-foot level. It is planned to continue the winze to the 980-foot level before starting stopes on the sixth level.

A re-organization of the company was effected at a general meeting of the shareholders held at Toronto on December, 7, 1921. The company as re-organized has a capital stock of 4,000,000 shares of $1.00 par value, all of which will be issued except 130,000 shares, which will remain in the treasury. In accordance with this plan the sale of 1,720,000 shares of the new issue of stock will leave outstanding in the hands of the bondholders only $342,000 of the new bond issue.

Tough-Oakes.—Tough-Oakes Gold Mines, Limited, resumed operations on April 15 with the de-watering of the mine. Development work began on May 22 with a force of 30 men which was later increased to 60.

During the year a total of 1,320 feet of development work was accomplished. This consisted of 899 feet of drifts, 404 feet of crosscuts and a 17-foot raise. The crosscutting was undertaken to prove the direction and extent of faulting that had taken place west of the main diabase fault and the upthrow caused by the vertical fault which cut off No. 2 vein immediately below the 400-foot level. The vertical fault has thrown the continuation of No. 2 vein into the adjoining Burnside property, now a part of the company's holdings, and the horizontal throw caused by the diabase fault is also southward into this property. Drifting at the 400-foot level on No. 3 vein showed a narrow but well defined vein carrying a little gold, and drifting on No. 11 vein for a distance of 263 feet developed ore of average grade with a width of 42 inches.

During the winter reconstruction of the surface plant was undertaken preparatory to resuming milling. Under the new scheme all ore will be handled from No. 3 shaft on the Burnside property which is being continued from the 400 to the 550-foot level.

Kirkland Lake Proprietary, (1919), Limited.—This company was formed in October, 1919, and is a re-organization of the Kirkland Lake Proprietary. The company holds a controlling interest in Aladdin Cobalt Company, Limited, and Tough-Oakes Gold Mines, Limited, and has absorbed Burnside Gold Mines, Limited. The registered office of the company is Finsbury Pavement House, London, Eng. The following are the directors: Capt. C. R. C. Jorgensen; Gen. Sir Bindin Blood, G. C. B.; Hon. K. H. Simpson, H. G. Latilla, A. Burt, H. J. Guntrip, secretary. S. C. Thompson, 43 Exchange Place, New York, is consulting engineer and W. R. Thomas, Kirkland Lake, manager. The capital of the company is one million shares of one pound each; 779,403 shares have been issued fully paid.

Wright-Hargreaves.—Wright-Hargreaves Mines, Limited, has an authorized capital of $2,750,000, in shares of $1.00 par value. The board of directors is as follows: Oliver Cavana, Jr., president; Edwin Lang Miller, vice-president and secretary; Gerard F. Miller, treasurer; Albert Wende, general manager; Ralph Hochstetter, Charles G. Duffy, Oliver G. Donaldson and Harcourt Ferguson.

Following is an abstract taken from the first annual report of the company, covering the year ending December 31, 1921:

The mill was started on May 1, and during the ensuing eight months treated 36,081 tons of ore; the recovery was $468,665.64 in gold bullion or an average of $13.00 per ton. Since the mill was started it has run ninety-two per cent. of the possible running time and treated an average of 175 tons of ore per day.

Most of the year's work was done on No. 2 vein, and since August 1 nothing has been done on No. 1 vein. The total amount of crosscutting and drifting up to the end of the year was 2,908 feet. Following are details regarding the stopes:

Stope.	Length in feet.	Broken ore in tons.
400 east	470	7,900
400 west	260	6,360
300 east	220	8,000
200 east	240	1,840
200 west	100	360

On May 1, when the mill was started, the broken ore on hand amounted to 2,000 tons; on December 1, 25,085 tons.

Additions to plant included a 650-cubic foot air compressor, two air receivers and an electric signal system; also equipment to use exhaust steam for heating, and to condense the remainder so as to return all the water to the boiler.

An average of 103 men was employed.

Matachewan

Thesaurus.—The Thesaurus Gold Mines, Limited, has a capital of $1,000,000 in shares of $1.00 par value. The board of directors is as follows: W. R. Smythe, president; W. J. Shields, secretary-treasurer; J. C. Nelson, managing director; M. J. Conkey and W. L. Forest.

The company owns 271 acres at the head of Matachewan lake on the north side of the township of Baden.

The property was operated with a force of fifteen men from May 10th to Nov. 1st. After building a camp, a boiler and hoist house, and a blacksmith shop, 60 feet of sinking and 22 feet of crosscutting was done; power being supplied by a small steam plant.

West Shiningtree

Burke.—In October the Hollinger Consolidated Gold Mines, Limited, took an option on the Burke-Cochrane-Landagne group of claims (T.R.S. 3767, T.R.S. 3768, and others) west of Granite lake in Fawcett township. The company sank three or four shallow diamond drill holes and discontinued work in January, 1922. It is understood that the option has not been exercised.

Hologden.—Hologden Mines, Limited, was incorporated December 10, 1921, with a capital of $1,000,000 divided into shares of $1.00 par value. The head office of the company is at North Bay, Ont. The directors are: Hart Martin, president; Charles S. McGaughey, secretary-treasurer; Savario De Rosa; Angelo Chirico; Italio Giaya; all of the directors live in North Bay.

The following unpatented claims in the West Shining Tree area have been transferred to the company: T.R.S. 4043, T.R.S. 4228, T.R.S. 4229, T.R.S. 4666, T.R.S. 4912, T.R.S. 4913, and T.R.S. 4914; these claims are south of MacDonald lake in Asquith township.

About the middle of March, 1922, six men in charge of Savario De Rosa began doing assessment work and, when inspection was made March 23, they were sinking a pit near the camp on T.R.S. 4043; this pit was then 14 feet deep.

Miller-Adair.—The Miller-Adair claims, T.R.S. 4008, T.R.S. 3698, T.R.S. 4121, and T.R.S. 3541, aggregating 152 acres, are now owned by Miller-Adair Mines, Limited.

This company was incorporated June 3, 1919, but as yet has not done any work. The capital stock consists of 2,000,000 shares having a par value of $1.00 each; 1,000,000 shares have been issued to John Adair, Archie S. Burton, Charles A. Gentles, and Charles Millar, the vendors of the claims. The directors are: Charles Millar, president; Charles A. Gentles, vice-president; George R. Sproat, secretary-treasurer; Andrew W. Hunter, Charles H. Kemp; all of Toronto.

Wasapika.—The Wasapika mine in the West Shining Tree area, owned by Wasapika Consolidated Mines, Limited, was idle in 1921. George R. Rogers is president; James E. Day, vice-president; and Reginald E. Hore, secretary; all these officers reside in Toronto.

On November 24, 1921, a new company, Ribble Mines, Limited, was incorporated with a capital of $2,000,000. This company has acquired control of the Wasapika Consolidated Mines, Limited, and will operate the Wasapika mine, commencing in the spring of 1922. The head office of the new company is at 304 C.P.R. Building, Toronto, and the directors are: George R. Rogers, president and general manager, Toronto; Reginald E. Hore, vice-president, Toronto; James E. Day, Toronto; L. J. Lahay, Toronto; J. C. Mahon, Cobalt.

White Rock.—White Rock Mining Company, Limited, mentioned in the last report of this Department, resumed work in the spring of 1921. This company is prospecting the Saville vein, which strikes in a northwesterly direction and dips to the southwest at about 65 degrees.

On March 22, 1922, the date of last inspection, the shaft was 175 feet deep and levels had been opened at 65 and 170 feet. This shaft is vertical, divided into two compartments, and measures 6 feet 4 inches by 11 feet outside the timbers. It was started at the top of a 65-degree incline that had been sunk 45 feet on the vein, and as much of this incline as was practicable was used to form the upper portion of the vertical shaft. On the 65-foot level the work done consisted of a crosscut, 21 feet long, from the shaft to the vein, 165 feet of drifting to the northwest and 100 feet to the southeast. On the 170-foot level there was an 86-foot crosscut to the vein, 35 feet of additional crosscutting, 140 feet of drifting to the northwest and 120 feet to the southeast.

The machinery includes two locomotive-type boilers, a 50-h.p. and a 35-h.p., an 85-h.p. Peerless engine driving a 300-cubic foot Gardner compressor, a 6-inch by 8-inch Jenckes hoisting engine, a 9-inch by 14-inch Mitchell jaw crusher, a 15-h.p. Jewel engine to drive the crusher, a 2-stamp Tremaine mill, a circular saw, and an O. and S. engine to drive the saw.

A small quantity of ore was stoped above the first level, stamped in the Tremaine mill and amalgamated.

The directors, all of whom live in Sudbury, are: William McVittie, president; W. Arthur Evans, vice-president; Charles Jessup, Maurice Cohen, Charles McCrea, M.P.P. A. J. Manley, Sudbury, is secretary, and William Stevenson, Shining Tree, Ont., superintendent.

Howry Creek

The three gold prospects mentioned below are in the Howry Creek area and were described in the last Annual Report:

Bousquet.—Bousquet Gold Mines, Limited, continued to prospect its property near Howry Creek until October, when all work was stopped. Besides doing considerable trenching, the company sank a 2-compartment shaft to a depth of 110 feet, and did 280 feet of lateral work on the 110-foot level.

Wm. B. McPherson, Imperial Bank Building, 171 Yonge Street, Toronto, is secretary of the company.

Howry Creek.—The Howry Creek Mining Corporation, Limited, stopped work on December 21, 1921. The underground work done up to that date was as follows:

An adit was driven a total distance of 428 feet; at the point where it was expected the vein would be cut, only a tight fracture in the quartzite was found.

About 110 feet east of the line of the adit a 5-foot by 7-foot shaft was started and sunk 50 feet. The vein in the lower part of this shaft is reported to be about 20 inches in width.

Near the east end of the outcrop a pit, 10 feet deep, was sunk.

A. K. Anderson of Ottawa was superintendent.

Majestic.—Majestic Gold Mines, Limited, did a little prospecting on one of its claims about half a mile west of West River station on the Algoma Eastern railway.

When the last inspection of this property was made (February 16, 1922) No. 1 shaft was 33 feet deep and a pit, being sunk about 160 feet to the northwest of the shaft, was ten feet deep. Small camps and a boiler house have been built. The latter building contains a Nagle locomotive-type boiler, a small Canadian Rand compressor and an Anaconda-type hoist.

M. A. Attalah, 213 Carlton Street, Toronto, is president of the company, and Peter Greco is mine superintendent.

Silver

Cobalt

Aladdin.—The Aladdin Cobalt Company, Limited, operated during most of the past year on the southeast portion of the Chambers-Ferland property; the work was done through the Right-of-Way shaft which was leased. Good results were obtained in the early part of the year and several new veins were encountered close to the Nipissing boundary. Unfortunately, on getting to the Keewatin the results were disappointing and the work was discontinued in November. About 20 men were employed under superintendent John Matheson.

During the period from January to November the development work amounted to 1082 feet divided as follows: drifts 465 feet; crosscuts 386 feet; raises 170 feet; winzes 61 feet. The production was 38,031 ounces of silver which yielded a return of $22,774.82.

As Kirkland Lake Proprietary, 1919, Limited, was re-opening the Tough-Oakes gold mine it was decided to suspend work at the Aladdin. Mr. W. H. Goodchild made a geological examination of the Aladdin in November and reported that the company's property lying between the Nipissing and LaRose mine may still be ranked as first-class prospecting ground, and it is expected that operations may be resumed in the near future.

Bailey.—The Bailey Silver Mines, Limited, with a capitalization of $1,250,000, owns and operates the Bailey mine at Giroux Lake and the mill formerly owned by Northern Customs Concentrators, Limited, at North Cobalt. In December a lease was taken on the Silver Cliff mine.

The officers of the company are: A. J. Young, president; W. R. Sweeney, secretary-treasurer; G. C. Bateman, consulting engineer, and R. E. Dye, mill superintendent.

During the year ending December 31, 1921, the Bailey mine shipped 11,600 tons of ore from which was recovered 81,749 ounces of silver. This ore came from 5A and 5B veins above the fifth level, and also from the extension of the Big Pete vein workings above the fourth level.

The mill treated a total of 49,619 tons and received a gross revenue of $141,925.00, from which was realized an operating profit of $37,813.00. This ore came from the following properties:

Bailey mine	11,600.21	tons
Silver Cliff mine	247.79	“
La Rose mines	36,364.91	“
Aladdin Cobalt Co.	607.01	“
Silver Leaf dump	180.84	“
Ophir dump	53.95	“
Silver Queen mine	448.76	“
Hermo Mining Co. (Reliance)	115.19	“
Total	49,618.66	tons

Cobalt A-53.—The Cobalt A-53 property in Gillies Limit was operated by J. J. Byrne with a force of five to six men during the last two months of the year. About 100 feet of drifting was done on the 60-foot level, and during the winter months a 40-foot winze was sunk from this level at a point southeast of the shaft.

The property is owned by the Cobalt A-53 Silver Mining Company, Limited, the officers of which are: R. J. Hart, Toronto, president; Edwin Stansbury, first vice-president; A. W. Hennessey, second vice-president; H. S. Honsberger, 119 Bay St., Toronto, secretary-treasurer; K. Nelson, Benjamin Trumin and W. H. Matthews.

Coniagas.—The Coniagas Mines, Limited, has a capitalization of $4,000,000, divided into shares of a par value of $5.00. The company owns the Coniagas mine at Cobalt and the Coniagas Reduction Company, Limited, whose smelter is at Thorold.

The board of directors consists of R. W. Leonard, president, St. Catharines; Alex. Longwell, vice-president, Toronto; F. D. Reid, general manager, Cobalt; R. P. Rogers, Woodstock; A. L. Bishop, St. Catharines; H. H. Collier, St. Catharines; R. L. Peek, Deschênes, Quebec. J. J. Mackan of St. Catharines is secretary-treasurer.

During the year the Coniagas Reduction Company, Limited, shipped 1,486,857 ounces of fine silver and treated 1,413 tons of ore (dry weight). The average number of men employed was 94.

The following information regarding the operation of the Coniagas mine is taken from the annual report of the company for the year ending October 31, 1921:

> Development work at the mine consisted of exploring further small blocks of undeveloped ground, and of developing stringers and small veins discovered in stoping. This work disclosed a large tonnage of low-grade milling ore. The underground electric haulage system was completed. The work performed during the year included 595 feet of drifting, 112 feet of crosscutting, 23 feet of winze-sinking and the stoping of 110,840 tons of ore. Shipments of high grade ore amounted to 25.46 tons dry weight, averaging 4,406.63 ounces of silver per ton. The concentrating mill and flotation plant

were operated continuously during the year, the ore milled being 113,279 tons or an average of five and a half tons per stamp per 24 hours. Mill heads averaged 11.3 ounces per ton. Shipments of high grade concentrates amounted to 402.47 tons, averaging 1950.26 ounces silver per ton.

The flotation plant, which treats tailing from the concentrating mill and reground sand from the tailing pile, made an extraction of 68.29 per cent., leaving a tailing of 1.62 ounces of silver per ton. Flotation concentrate amounted to 536.88 tons, averaging 655.24 ounces silver per ton.

Old sand tailing treated during the year amounted to 19,125 tons, and an average of two ounces per ton was recovered. Cyanidation of old slime tailing was carried on from May 17 to October 31, the yield being 50,000 ounces of silver from 14,931.6 tons treated.

During the year 1,301,514.91 ounces of silver were shipped, and $800,000 in dividends were paid.

Dickson Creek.—The Dickson Creek (Cobalt) Silver Mines, Limited, continued development on its property in the northeast quarter of the north half of lot nine, concession V, Bucke Township, from June 21 to the end of 1921. H. Hollands-Hurst, Haileybury, is superintendent, and seven men are employed.

The shaft was continued from 250 to 325 feet, and an 18-foot station cut at the 300-foot level; from this station crosscuts were driven 104 feet northwest and 109 feet southeast.

The head office of the company is at 33 Old Broad Street, London, E.C. 2. The directors are: Thos. Dempster, president, Perth, Scotland; J. A. Crumble; J. J. Knight; A. E. T. Price; and Phillip Hurst.

Kerr Lake.—Kerr Lake Mines, Limited, has a capitalization of $2,400,000 in shares of $4.00 par value. The head office is at 61 Broadway, New York. The officers of the company are: Adolph Lewisohn, president; Sam A. Lewisohn, vice-president; E. A. Westlake, secretary-treasurer; H. A. Kee, Cobalt, manager. An average of 90 men was employed.

During the fiscal year ending August 31, 1921, the total advance by drifting, crosscutting, raising and sinking amounted to 3341.25 lineal feet. Most of the exploration during the past year was done in the northerly and southerly extensions of the No. 3 diabase vein structure on different levels. This work exposed some high grade ore as well as a little milling ore, though none of the discoveries in the Kerr Lake area proved of great importance.

During the early work on No. 3 vein high-grade ore shoots were procured in known horizons, the lower portions of which were about 125 feet above the lower Keewatin-diabase contact; recently pockets of high grade ore have been found close to this contact in both formations. It is planned to continue development at favourable levels along the contact in Kerr Lake and Hargrave areas.

The development and stoping figures for the year September 1, 1920, to August 31, 1921, are as below:

Drifting	1,975.50	Lin. feet
Crosscutting	889.50	Lin. feet
Raising	396.75	Lin. feet
Sinking	79.50	Lin. feet
Total Development	3,341.25	Lin. feet
Total Stoping and Sideslashing	2,939.00	Sq. feet
Total development to August 31st, 1921:		
Previous to September 1st, 1920	59,890.55	feet
Total for year	3,341.25	feet
Grand Total	63,231.80	feet

Development work was continued till January 31, 1922, and an additional 1,104 feet driven as follows: drifts 894 feet, crosscuts 60 feet, raises 150 feet.

The recovery from the year's operations was 194,352 ounces of silver and 17,096 pounds of cobalt. Ore milled amounted to 11,235 tons.

The Hargrave property, consisting of 80 acres, was acquired in March for a purchase price of $16,500. Since that time a small ore shoot has yielded about 36,000 ounces of silver from high-grade ore, and a further production is anticipated.

Four dividends of $75,000 each were paid during the year which brings the total distribution to date to $8,610,000, in addition to a capital distribution of $600,000 in 1919, or $1.00 per share.

The company began operations on the Goldale (gold) property in Porcupine in April, 1922.

La Rose.—La Rose Mines, Limited, with a capital of $1,500,000, in $1.00 shares, operated the La Rose, Violet, Princess and University mines at Cobalt. The officers of the company are: D. Lorne McGibbon, president; Shirley Ogilvie, vice-president; Stephen J. Le Huray, secretary-treasurer; G. C. Bateman, general manager. The head office of the company is at 260 St. James St., Montreal.

During the year the company produced from all sources 637,042 ounces of silver having a net value of $390,957.51, as compared with 410,445 ounces in 1920, having a value of $313,995.74. The profit on production was $126,088.83. The average selling price was 63.54 cents per ounce, and the cost of production 46 cents per ounce, as compared with 83.41 cents and 73.27 cents in 1920. The current net surplus on Dec. 31, 1921, amounted to $555,910.00. This is the most favourable showing for any year since 1916.

The 36,365 tons of ore shipped to the concentrator had an average content of 15.7 ounces per ton and yielded 659 dry tons of concentrates averaging 759 ounces per ton, or a total of 500,114.53 ounces for which the smelter return was $298,677.63. The cost of concentration was $102,395.78, or $2.81 per ton milled, and the extraction 87.6 per cent. on a ratio of concentration 55 to 1.

The following tables give a summary of the work done on the several properties and the output of each during the year:

Work done:—

	Shafts ft.	Drifts ft.	Crosscuts ft.	Raises ft.	Stations cu. yds.	Stopes cu. yds.
La Rose	4.5	7.5				476
Princess	45.5	475.	548.5	54.	122	2,122
University	22.5	1,486.5	1,904.5	348.		6,031
Violet	65.0	224.0	57.5	9.5		344
Total	137.5	2,193.0	2,510.5	411.5	122	8,973

The production by properties was as follows:—

	Tons	Value
La Rose	11.00	$ 18,381 82
Princess	16.81	7,237 32
Violet	1.70	1,446 48
University	29.13	109,861 92
Concentrate	659.26	500,114 53
Totals	717.90	637,042 07

The *Violet* mine remained flooded below the 330-foot level until August when it was pumped out and a crosscut started from the bottom of the winze on the 530-foot level. No. 4 vein was encountered 35 feet south of the winze where it showed a width of from five to six feet of milling ore. It was drifted on for a distance of 225 feet and in the course of drifting and preparations for stoping there was removed a total of 1,599 tons containing 49,730 ounces of silver, or an average of 31.1 ounces per ton. In December work on the 530-foot level was stopped to permit sinking the winze to the 600-foot level. This depth has now been reached and a crosscut has been started to intersect the vein.

The *Princess* mine production came from the cleaning up of old stopes, from veins previously discovered, and from the extension of No. 1 vein below the third level which was developed by an incline. Practically all of the known ore has been mined. and the possibilities of new discoveries are limited. It was decided to sink from the lowest level to explore at greater depth a small area where the geology is favourable, and this work is now proceeding.

The *University* mine was operated continuously during the year, and contributed 70 per cent. of the total output of the combined properties. The profit realized was almost sufficient to pay off the indebtedness to the La Rose company. The main stope opened in 1920 was exhausted although it still contains broken ore, but a new ore body lying to the north of this stope was discovered close to the contact of the diabase with the slates. In places it has a width of 20 feet of milling ore together with small stringers of high grade. Contrary to the general experience of the Cobalt camp practically no ore has been found in the conglomerate, the silver here being almost entirely confined to the overlying slates, of which there is still a considerable area to be prospected.

Mining Corporation.—The Mining Corporation of Canada, Limited, has a capital of 1,660,050 shares of a par value of $5.00. The directors and officers are: J. P. Watson, president; W. R. P. Parker, first vice-president; G. M. Clark, second vice-president; E. H. Rose, J. G. Watson, Thos. Plunkett, Capt. C. E. Trafford, directors; Scott Turner, consulting engineer; M. F. Fairlie, mine manager; G. C. Ames, secretary. The head office is 1512-1520 Bank of Hamilton Building, Toronto.

The following information is taken from the eighth annual report of the corporation:

> The Cobalt Reduction Company treated 72,664 tons of ore in the concentrating plant and produced 548.44 tons of concentrate containing 928,845 ounces of silver. Of this ore 29,207 tons came from the Mining Corporation, 43,385 tons from the Buffalo, 50 tons from the Foster, and 22 tons are classed as "sundry." The slime from the concentrating plant, 35,986 tons, was treated in the cyanide plant and 301,219.70 ounces of silver recovered. The high-grade plant treated all the concentrate produced in the low-grade mill, the high-grade ore from the mine and 475.80 tons of purchased high-grade ore and concentrate. The refinery produced 1,966,946.84 ounces of refined bullion. The flotation plant was not operated during the year.
>
> Ore reserves are estimated at 102,300 tons containing 1,935,750 ounces of silver, as against 103,603 tons containing 2,181,000 ounces in 1920.
>
> Mining and milling were discontinued from March 7 to May 25 while changes were being made to increase the milling capacity.
>
> Exploration at the Foster failed to develop any new ore and the property was closed down in October.
>
> An option was taken on the Frontier mine in South Lorrain and development will be carried out in 1922.

Nipissing.—The Nipissing Mines Company, Limited, has an authorized and issued capital of 1,200,000 shares of a par value of $5.00. The officers of the company are: E. P. Earle, president; Alexander Fasken, secretary; P. C. Pfeiffer, treasurer. The directors are: E. P. Earle, Richard T. Greene, August Heckscher, R. B. Watson of New York, and W. H. Brouse, John H. Black and David Fasken of Toronto. The head and corporate office is in the Excelsior Life Building, Toronto, and the New York office is at 165 Broadway.

The operating company is the Nipissing Mining Company, Limited, with an issued capital of $250,000 in shares of $100.00 par value. The officers are: David Fasken, president; E. P. Earle, vice-president; Alexander Fasken, secretary; P. C. Pfeiffer, treasurer. The directors are: John H. Black and David Fasken of Toronto; E. P. Earle, Richard T. Greene and R. B. Watson of New York. The operating officers are: R. B. Watson, general manager; Hugh Park, manager; James J. Denny, mill manager. The head office is in the Excelsior Life Building, Toronto.

During 1921 production amounted to 3,156,775 ounces of silver having a gross value of $1,869,566.41, and a net value of $968,768.51. The total cost of producing this silver was 900,779.90, or 28.53 cents per ounce, or $11.16 per ton of ore treated. The operating cost represents 48.2 per cent, and the operating profit 51.8 per cent of the gross value. Up to the end of 1921 the company had shipped a total of 61,855,567.39 ounces of silver, for which the net value received was $40,076,751.78. Of this total $23,640,000 has been paid in dividends. During the year a total of $900,000 or 15 per cent. of the capital was returned in dividends. The surplus on hand is $3,851,242.94.

Shipments in 1921 were:

	Tons	Fine ounces silver	Net value
Silver bullion	108.32	3,155,538.84	$1,828,095 80
Silver ore	2.43	66.26	46 38
Total shipments	110.75	3,155,605.10	$1,828,142 18
Less custom bullion	4.76	138,844.68	82,731 11
Shipments of Nipissing product	105.99	3,016,760.42	$1,745,411 07

The following information is taken from the seventeenth annual report of the company:

The various products treated in the high-grade plant were:

	Tons	Assay ozs.	Contents ozs.
Nipissing concentrate	1,511	1,498	2,263,084
Custom ore	73	1,812	131,517
Bi-products	41	2,301	95,665
	1,625	1,532	2,490,266

Formerly the ore was ground in a tube mill with water and bleaching powder and then sent to the cyanide treatment. The use of bleaching powder has been discontinued; the ground ore is now agitated in a 3 p.c. sulphuric acid solution to eliminate cyanicides, principally the oxidized compounds of nickel. After two water-washes the remaining acid is neutralized with lime and the usual cyanide treatment follows. This preliminary acid treatment results in a saving of from 25 to 30 lbs. sodium cyanide per ton of ore treated.

Residue produced amounted to 1,878 tons, carrying an average of 57 ounces silver and 6.8% cobalt. The cobalt market was very quiet; no residue shipments were made during the year.

The refinery treated precipitate from both mills and custom bullion containing 3,527,638 ounces.

Shipments of 3,155,539 fine ounces were made during the year.

The following shows the operations of the low-grade mill:—

	Tons	Assay	Ounces
Ore treated	80,720	41.58	3,356,318
Recovered in products			
Precipitate	41	23,953	976,584
Coarse concentrate	1,321	1,580	2,087,312
Fine concentrate	177	511	90,424
Total recovery			3,154,320

Average tailing, 2.48 ounces. Recovery, 93.98%.

Forty stamps ran 322 days, 18 hours, or 88.56% of possible running time, and crushed 250.1 tons per day, or 6.267 tons per stamp per day.

The above summary shows the results of the first full year's run since the closing of the picking plant for high grade ore. All the ore, high-grade and low-grade mixed, is now sent directly to the stamps. Notwithstanding an exceptionally difficult ore to treat compared with former years, the recovery was good and the treatment cost was lowered.

The following work was done underground in 1921:

Shaft No.	Drifting feet	Crosscutting feet	Raising feet	Sinking feet	Total feet	Stoping cu. yds.
63	1,564.5	1,252.0	353.5	37.0	3,207.0	8,166.0
64	26.5	....	310.0	....	336.5	906.3
73	630.5	1,581.5	596.0	....	2,808.0	6,855.3
Totals	2,221.5	2,833.5	1,259.5	37.0	6,351.5	15,927.6

The total underground advance during the year was somewhat less than in 1920, due partly to destruction by fire of the headframe at Shaft 73 in the month of April. The work done at Shafts 64 and 73 was consequently reduced. The fire did not affect operations at the mill, as extra tonnage was obtained from Shaft 63.

For some years past a large proportion of the ore produced has come from the north side of the lake within the town of Cobalt. Last year, however, more than half the underground development took place on the east side of the lake and the present ore reserves are about equally divided between the two sides.

Underground work was carried on in 128 faces exclusive of stopes, of which there were 23.

As usual, a number of new veins were found, but none was of much importance with the exception of Vein 251 in the Shaft 63 workings.

Good results were also obtained in blocking out new ore in Vein 64.

Shaft 63. There was a considerable increase shown in the tonnage extracted through this shaft due to the development of several small veins recently found and to work on the Little Silver vein, which was the first silver vein found on the Nipissing property; it still holds a reserve of 227,000.

The most satisfactory result from exploration was the discovery of Vein 251 by a crosscut from the second level. The drift at that level disclosed an ore shoot 70 feet in length with an average of 3 inches of ore assaying 3,500 ounces. A winze put down at the end of the year shows that the vein maintains its width and assay to a depth of 55 feet where the Keewatin was encountered. Drifts near the contact are now being driven from the bottom of the winze, with excellent results to date.

In this piece of ground lying west of Cart lake and known as Little Silver hill, a number of good veins have been developed and it is still being extensively explored.

Shaft 19. This old shaft was reopened during the year to extract the ore remaining No. 6 open cut which had not been worked since the early days of the property. It will produce some thousands of tons of average ore.

Shaft 64. Stoping and development on Vein 64 were considerably increased, due to the completion of haulage facilities to the main hoisting shaft on Vein 73. Substantial increases in ore reserves, both high grade and mill rock, resulted from this work. The vein occurs in a large fault which is only mineralized in spots. The average assay of the high grade ore is about 1,000 ounces, but parts of the vein will assay much higher over widths of from one to two feet. This vein will be one of the main producers during the coming year.

Although considerable exploration has been done to the north of Vein 64, the ground does not appear promising, and nothing of interest has developed.

Shaft 73. The older veins worked through this shaft continued to produce a large part of the ore milled, but such new veins as were found during the year proved of minor importance. Vein 490 was drawn on heavily, but still shows a fair amount of ore in reserve with possibilities of further increases.

Shaft 128. A fairly large area of comparatively thin conglomerate will be explored from this shaft. A few veins, small and low grade, occur here and there at the surface. The old level at 125 feet proved to be too deep to explore all the area, so a new level has been started at 75 feet.

O'Brien.—The O'Brien mine produced 1,506,384 ounces of silver in 1921; this is the largest amount since 1909, and makes the O'Brien now the second largest producer in Cobalt.

The underground work done during the year is summarized thus: 795 feet of drifting, 602 feet of crosscutting, 395 feet of raising, 19 feet of sinking, and the stoping of 56,119 tons of ore.

In the mill 58,924 tons of ore were treated; this makes the total ore milled from this mine to the end of 1921 546,789 tons. Of the 1,506,384 ounces of silver recovered during the year, thirty per cent was contained in bullion and seventy per cent. in concentrate. Several new tanks were added to the cyanide plant.

The total number of men employed during the year averaged 165; 100 of these were underground workmen, 33 were in the mill, and 32 at other surface work.

The mine is owned by M. J. O'Brien, Limited, of which the officers are: president, M. J. O'Brien, Renfrew; vice-president, J. A. O'Brien, Ottawa; mine manager, J. G. Dickenson, Cobalt.

Oxford Cobalt.—Oxford Cobalt Silver Mines, Limited, has an authorized capital of $1,000,000. The officers of the company are: A. H. Wilson, president; J. R. Shaw, vice-president; E. A. Rea, treasurer; G. W. Mahon, secretary; J. W. Russell, general manager.

This company owns mining claims A-100 and C-1000 in the Gillies Limit. During the latter half of the year on claim A-100 an 80-foot shaft was sunk and a station cut at the 75-foot level. On mining claim C-1000 170 feet of drifting was done on the 150-foot level of No. 3 shaft and 20 feet from No. 2 shaft. Eight men were employed.

Reliance.—The Reliance Silver claim near Cobalt was worked under lease by the Hermo Mining Company from August 1, 1921, to March 1, 1922.

W. H. Emens of Cobalt was in charge and had five men employed.

The following development work was done; the sinking of a winze from No. 1 shaft workings to 47 feet below the 50-foot level; the sinking of No. 2 shaft to a depth of 45 feet and 144 feet of drifting.

One hundred and fifteen tons of ore were shipped to the Bailey mill, which yielded 1.2 tons of concentrate assaying 553.6 ounces of silver per ton.

Silver Cliff.—The Silver Cliff mine was operated under lease by the Bailey Silver Mines, Limited, during the last two months of the year and 247.79 tons of milling ore was shipped to the company's concentrator for treatment.

Silver Queen.—Silver Queen mine was operated under lease by W. J. Post during the latter part of the year with a force of two men. A crosscut was driven 90 feet south on the 90-foot level during December and January.

During 1921 milling ore amounting to 448.76 tons was shipped to the Bailey mill.

From May to July, 1922, shipments were made to the Cobalt Reduction Company of 2.88 tons containing 3,660.27 ounces of silver, and metallics containing 493.95 ounces.

Victory.—Victory Silver Mines, Limited, was incorporated May 20, 1920, with a capitalization of $2,000,000, divided into shares of $1.00 each. The officers and directors, all of whom live in St. Catharines, Ont., are: president, A. Patterson; vice-president, W. K. Masterton; secretary-treasurer, F. E. Hetherington; directors, John Morton and A. G. Christopher. The head office is at 10 Queen Street, St. Catharines.

The company gave 750,000 shares of stock for the assets of the Victory Silver Mining Company, Limited; the mining claim involved was the "Hyland," a ten-acre claim, north of the Ophir mine and in the southeast part of lot 2, concession III, township of Coleman.

The shaft on this property was sunk by former owners to a depth of 200 feet. In 1921 the new company did 150 feet of drifting and 175 feet of crosscutting on the 185-foot level, in addition to sinking the shaft to a depth of 285 feet. Eleven men were employed under manager J. A. McVichie.

South Lorrain

Haileybury Frontier.—The Haileybury Frontier Mine in South Lorrain was operated during the year by H. F. Strong of Haileybury for the Dominion Mines and Quarries, Limited, with a force of about 30 men. James G. Harkness was superintendent.

During the first five months of the year about 1,000 feet of drifting was done on the 150-foot level. During the next three months the shaft was deepened to 150 feet, and a station cut at the 300-foot level. Some 400 feet of development work was done on the 300-foot level before November 13, when the Mining Corporation of Canada took a working option on the property and began working it as the Lorrain Operating Company. About 300 feet of additional development work was done by this company on the 300-foot level. A diamond-drill hole 478 feet in depth was also put down to the diabase contact, which was encountered at 450 feet.

In December a shipment of 16.85 tons of high-grade ore containing 47,374.43 ounces of silver was made to the Dominion Reduction Company at Cobalt.

Keeley.—The Keeley Silver Mines, Limited, operating the Keeley mine in South Lorrain, has a paid up capital of £133,000 sterling. The head office of the company is at 65 Broad St. Ave., London, E.C. The directors are:—E. Hooper, chairman, A. H. Collier, E. Turk and J. C. Williamson. Dr. J. Mackintosh Bell is general manager.

An average of 65 men was employed.

The property was closed from December 1, 1920, to April 6, 1921, and milling began in June.

Mining operations have been limited to the No. 3 shaft on the following levels:

	No. 3	No. 4	No. 5	No. 6	Total in feet
Drifts	63	31	826	506	1426
Crosscuts	21	..	57	79	157
Side-slashing	9	47	48	40	144
Raises	..	..	74	38	112
Winzes	..	..	75	..	75

Mill at Keeley Silver Mine, 1921.

The total production was 313,229 ounces of silver and 59,530 pounds of cobalt, divided as follows; 181,313 ounces of silver and 18,644 pounds of cobalt in high-grade ore, and 131,916 ounces of silver and 40,886 pounds of cobalt in mill concentrates.

The mill treated 9,204 tons, and produced 266.5 tons of concentrates. The heads averaged 17.8 ounces and the tails 3.5 ounces, giving a recovery of 80.5 per cent.

New equipment includes a 52-horse power electric hoist at No. 3 shaft, and a 10-horse power triplex electric pump on the sixth level.

A number of new veins were discovered during the year. The more important were No. 15, which branches easterly from No. 6 at the fifth level, and

No. 16, branching westerly from the Woods' vein at the sixth level. Development along the No. 16 has been carried on at both the fifth and the sixth levels, and along the No. 15 only at the fifth level. Development on the Woods' vein at the sixth level along a much shattered overthrust fault showed continuous ore from a point 25 feet south of the main crosscut to a point 220 feet north, or for a total distance of 245 feet.

Elk Lake and Gowganda

Alpine.—Alpine Silver Mines, Limited, has a capitalization of $2,000,000 in $1.00 shares. Charles O. Taylor, Chicago, Ill., is president, and Thos. B. Tough, Huntsville, Ont., vice-president. The company owns mining claims in the Township of Van Hise near Spawning lake.

During the summer and autumn, camps, a magazine and an office were built, a 45-horse power locomotive-type boiler and a three-drill air compressor were installed, and an adit was advanced 120 feet. There were 10 men employed under E. J. Thompson.

Collins Mine.—In July F. Howard Collins resumed work on his property at Leroy lake with a force of seven men. Most of the work was done on the 288-foot level near the Keewatin-diabase contact. This consisted of drifting 25 feet north and 36 feet south and crosscutting 83 feet to the east. A small amount of drifting was also done in No. 2 shaft at a depth of 48 feet.

Miller Lake O'Brien.—The Miller Lake O'Brien mine near Gowganda is owned and operated by M. J. O'Brien, Limited. J. G. Dickenson, Cobalt, is manager and H. G. Kennedy, Gowganda, resident superintendent.

Development work in 1921 consisted of 1,424 feet of drifting and crosscutting and 54 feet of raising. There were 9,353 tons of ore stoped and 15,878 tons of ore hoisted. The mill treated 8,425 tons of ore and the production was 245,624 ounces of silver. An average of 68 men was employed.

A shortage of waterpower toward the end of the year interfered with the work, and necessitated closing the mill from November, 1921, to May, 1922. To provide greater water storage capacity, a dam was built on the east branch of the Montreal river.

Early in 1922 the Miller Lake O'Brien mine bought the property of The Bonsall Mines, Limited, consisting of eight claims adjoining the Miller Lake O'Brien on the west.

Northcliff.—On October 1, Northcliff Mines, Limited, resumed work on its property on the northwest arm of Gowganda lake. On November 1 the adit measured 260 feet and 40 feet of drifting had been done 125 feet from the portal. Seven men were employed under Norman E. Dye until the mine was shut down for the winter.

Ontario Solid Silver Mines.—Col. D. Shepp let a contract in December, 1921, to Roy Sullivan and three associates to sink a 50-foot shaft on the company's property in Cane township, adjoining that of the Cane Silver Mines. This was completed February 18 and work was resumed on March 11, 1922, with the intention of sinking to 100 feet.

Sanderson.—The Sanderson claims, H.R. 404-411 and L.O. 314-15 in Lawson township near Wigwam were worked under option by Stewart Troop of Montreal, from April to July 20. A shaft was sunk on claim H.R. 406 half a mile north of the Bishop mine to a depth of 83 feet, and a boiler house and smithy built. From six to eight men were employed.

Castle.—The Trethewey Silver Cobalt Mining Co., Limited, operated the Castle property with a force of from 30 to 55 men until June 25, when a fire destroyed the power house. The shaft was sunk from 70 feet to 260 feet and 300 feet of drifting and crosscutting was done at the 160-foot level, Murray D. Kennedy is manager.

At the annual meeting in January, 1922, a new company, the Castle-Trethewey Mines, Limited, was formed with a authorized capital of $2,000,000 in shares of $1.00 each. Of this capital stock 400,000 shares were exchanged for the stock of the Castle Mining Company, Limited, and 1,600,000 shares were offered to shareholders at 10 cents per share to provide funds for future work.

IV.—SOUTHERN AND EASTERN ONTARIO

Calcite and Dolomite

Baptiste Lake Dolomite Deposit.—In 1916 Alex. Watson of 76 Coleridge Avenue, Toronto, bought a piece of land on the southwest shore of Baptiste lake, with a view to prospecting a deposit of dolomite which outcrops about 30 chains west of Baptiste station on the Irondale, Bancroft and Ottawa branch of the Canadian National Railways. The deposit lies beside the railway, and outcrops on the side of a hill some 350 feet high. In 1921 Mr. Watson transferred his holdings, which are in lots 23, 24, and 25, concessions IV and V, township of Herschel and contain 124 acres, to the Ontario Dolomite Manufacturing Company, Limited. This company hopes to market the dolomite for the manufacture of paints.

The property was visited on September 21, 1921, when five men were working under Mr. Watson's supervision. As near as could be judged at that time, the dolomite occurs in the form of a bed having a dip of from 20 to 40 degrees to the south and a strike of about 135 degrees. As the property was visited late in the day and during a rainstorm, no measurements were taken, but the portion of the deposit exposed at the point where most of the stripping has been done showed six feet of rather impure dolomite at the base, the impurities consisting of serpentine and mica in streaks; above this there was from 15 to 25 feet of dolomite of apparently good quality exposed, and the thickness may be greater, as the upper contact was not examined. The dolomite is underlain by a gneissoid rock.

Work was carried on from August to October, stripping, test-pitting, and drilling with a shot-drill.

The officers of the company are:—president, Robert M. Smith, Toronto; vice-president, F. W. Burnip, Toronto; secretary-treasurer, Harold A. Burnip, Toronto. The office of the company is in the Standard Stock Exchange Building, 56 King Street West, Toronto.

Caldwell Calcite Deposit.—A large deposit of calcite, white to cream in colour, has been discovered on the farm of James Crain in the west half of lot 4 in the seventh concession of the township of Palmerston, county of Frontenac. Thomas B. Caldwell of Perth, Ont., bought the mineral rights, and in October and November, 1921, quarried about 200 tons for experimental purposes. This work was done at the southeast end of the lot at a point where a width of 60 feet of calcite, apparently free from impurities, is exposed; neither wall was uncovered at this excavation. The strike of the deposit is approximately east and west. Twelve hundred feet west of the opening mentioned above, at the edge of a beaver meadow, a face of pure calcite is exposed 35 feet high; the deposit is 60 feet wide at this point. The haul to Robertsville siding on the Kingston and Pembroke branch of the Canadian Pacific Railway is about two miles.

Corundum

Corundum, Limited.—The re-treatment mill at Craigmont was operated for four and three-quarter months in 1921, closing on June 14. During that time 11,256 tons of tailings were re-treated, producing 289 tons of corundum. An average of 30 men was employed. E. B. Clark of Craigmont is manager.

Feldspar

Eureka Flint and Spar Co., Limited.—The Company's property is in Portland township, concession XI, lot 16. It closed down its Emery feldspar property near Verona in April, 1921, and had not resumed work up to the end of the year. John Wilkes, 39 Logan Avenue, Trenton, N.J., is field manager for the company and Richard Wagar of Verona is superintendent of the Emery quarry.

Federal Feldspar, Limited.—The McGregor feldspar mine, in lot 25, concession III, Bedford township, near Tichborne and owned by this company, has not been worked since November, 1920. John O'Toole, 250 Slater Street, Ottawa, is vice-president and manager.

Feldspar Quarries, Limited.—This company owns the Brebner and Timmins feldspar quarries near Verona and the O'Holloran feldspar quarry near Perth, all of which have been mentioned in former Annual Reports. All three properties were closed in the spring of 1921. and have not been worked since.

The officers of the company are:—president and managing director, W. H. Despard, 48 Crescent Road, Toronto; treasurer, Donald A. Cameron, Toronto; secretary, Miss N. F. Martin, Toronto; manager, Gordon C. Edwards, Verona, Ont.

Feldspar, Limited.—This is the well-known Richardson feldspar mine on lot 1, concession II, Bedford township. Nothing was done at this property from December, 1918, until August, 1921, when men were engaged to sort the dump. This work was still in progress at the end of the year, and was employing from 10 to 14 men. J. Ralph Scott, R.R. No. 1, Hartington, Ont., is manager.

A new road is being built to lead due north from the mine to a junction with an old road a mile from Glendower station.

Gardner Feldspar Co.—This company worked a feldspar vein on the Babcock farm, Loughborough township, concession XI, lot 1, near Holleford, until February 12, 1921. In the autumn Joseph H. Mendels of Perth shipped some feldspar from the deposit.

International Feldspar Company, Limited.—The Hoppins feldspar mine, Bedford township, concession III, lot 2, owned by this company, was shut down in March, 1921. John A. McLean, 316 Moffatt Block, Detroit, Mich., is president of the company.

Long Lake.—Loughborough township, concession IX, lot 11. This is the property on Long lake, Frontenac county, first worked by O'Brien and Fowler in 1920. From December 12, 1920, until the latter part of February, 1921, Sherman Orser and Dr. S. C. Wilson shipped a few carloads of feldspar from one of the veins. William Raymond was foreman.

Rinaldo McConnell of Perth, Ont., worked during 1921 on two feldspar veins in Bathurst township:

Kirkham.—Bathurst township, concession VII, lot 3. This deposit has been mentioned in previous reports. Work was carried on intermittently during the early part of 1921, and a force of ten men was employed from May to August 12, since which date the property has lain idle. James Benton was foreman.

Keays.—Bathurst township, concession IX, lot 20. On August 12, Mr. McConnell began to prospect a vein of pink feldspar, about 28 feet wide, in syenite, on the farm of William J. Keays. Drilling was done by hand with a force of six men until work was stopped towards the end of October. The feldspar quarried was shipped from Glen Tay, seven miles from the pit.

The Mount Eagle Feldspar Company, Limited.—In March, 1921, this company acquired the Watson feldspar property near Hybla from Universal Silicates, Limited. It is situated on lot 22, concession VI, Monteagle township, and was first mentioned in the 29th. Annual Report of this Department.

Work was carried on until July 28, since which time nothing further has been done.

"No. 1" deposit is an irregular pegmatite vein containing feldspar, considerable quartz and some graphic granite. This was the deposit work by Universal Silicates, Limited. The open-cut on the vein is about 38 feet long, 28 feet wide and from 15 to 20 feet deep. A few small pieces of euxenite[1] have been found in this vein.

"No. 2" deposit lies north of No. 1. Here, an open cut, approximately 55 feet long, 20 feet wide and from 15 to 30 feet deep, has been made in the side of a hill; from the inner face of the cut an adit 95 feet long has been driven into the hill on the vein. At the portal the vein contains from 6 to 8 feet of good feldspar, but at one point in the adit it widens to 12 feet. The feldspar above the adit has not been stoped,

The machinery on the property includes a Leonard and Son locomotive-type boiler, 42 inches diameter and 17.3 feet long, an Ingersoll-Sergeant compressor; a Jenckes hoist, about 7 inches by 9 inches, and a derrick.

The head office of the company is at 327 Union Building, Cleveland, Ohio. J. O. Brown, Cleveland, is president; M. B. R. Gordon, manager; and Joseph C. Duval, superintendent.

Orser-Kraft Feldspar, Limited.—The address of this company is Box 266, Perth, Ont., and the officers are now as follows:—president and manager, Sidney H. Orser, Perth, Ont.; vice-president, Edward P. Erion, Buffalo, N.Y.; treasurer, Leo B. Seitz, Buffalo; secretary, Miss Dencie M. Orser, Perth; directors, C. G. Grauer, Buffalo, N.Y. and Gustav Metz, Buffalo, N.Y. In 1921 the company mined feldspar from the *John Burns, William J. Keays,* and *Morrow* properties, all of which were mentioned in the Thirtieth Annual Report, and also opened a new deposit on the *Alex. Palmer* property.

The *Burns* deposit is in Bathurst township, concession III, lot 2. Three men were employed here drilling by hand until March, 1921.

The *Keays* is located in Bathurst township, concession IX, east half of lot 21. In January, 1921, Orser-Kraft Feldspar, Limited, began to test a large vein of white feldspar on this property and worked intermittently until autumn. The vein has a northeasterly strike.

The *Morrow* mine is in South Sherbrooke township, concession V, lot 13. Mining was continued at this feldspar deposit until October 31, 1921, when market conditions made a shut-down necessary. From 5 to 12 men were employed under superintendent Elwood Orser. Euxenite[1] is still found in this quarry.

Pennsylvania Pulverizing Company.—This company, with headquarters at Lewiston, Pa., operated two properties known as the *Woodcock* and *Robinson,* respectively.

The first mentioned is located in Monteagle township, concession VIII, lot 17. In September, 1921, stripping was commenced on a vein of feldspar on the farm of *Harvey Woodcock* near Hybla. When last inspected (Oct. 13, 1921), five men were engaged in stripping the vein at a point where the merchantable feldspar appeared about 30 feet wide. The strike of this vein is about 60 degrees. At two places in the portion stripped, some beautiful green feldspar (microcline?) has been found; in one place, the green spar is interlaminated with white feldspar, and in another with red orthoclase. The prospecting is being carried on under the direction of William J. Woods, Lewiston, Pa., assistant general manager of the company, and Robert H. Thompson, Hybla, Ont., superintendent.

The *Robinson* prospect is located in Bedford township, concession 11, lot 30. Harry J. Cain of Tichborne, Ont., has stripped a feldspar vein on the John Robinson farm. No shipments were made.

Rock Products Company.—The Rock Products Company, whose feldspar-grinding plant is in Silica, Ohio, carried on work in 1921 at the three feldspar properties mentioned below. A. G. Minehart, Nicholas Building, Toledo, Ohio, is treasurer and manager of the company.

1.—During January the company commenced to test a vein of feldspar on the farm of *William D. Noonan,* lot 18, concession IX, Bathurst township. After several cars had been shipped, work was discontinued in April.

2.—Afterwards the company opened a new deposit on the farm of *James Keays* in the west half of lot 21, ninth concession of Bathurst township. The feldspar here is of a pale pink colour and occurs in syenite in a vein striking N. 20 degrees E. (magnetic). At the time of last inspection (January 4, 1922), the main pit measured 53 feet long, 23 feet wide, and 24 feet deep; 20 feet north of this pit is another 48 feet long, 28 feet wide, and 8 feet deep. Both pits are on the same vein.

---

[1] Euxenite, a Radio-Active Mineral, by Willet G. Miller and Cyril W. Knight, Ont. Dept. Mines, Vol. XXVI, pp. 314-317.

The plant consists of a Clyde Iron Works vertical tubular boiler, 8 feet 4 inches long and 42 inches in diameter, a friction-drum hoisting engine, and an 85-foot steel derrick with a 70-foot steel boom. From 12 to 15 men were employed here under superintendent James Benton. The mine post office address is R.R. No. 1, Balderson, Ont.

3.—For a few weeks during the autumn the company also had three men at work on a feldspar prospect near Tichborne, owned by *Charles Clobridge* of that village, and situated in lot 24, concession I. Hinchinbrooke township.

Storrington Feldspar Co., Limited.—Storrington township, concession XIII, lot 8. This company was incorporated in May, 1921, to work the Alexander Teeples feldspar property, mentioned in the Thirtieth Annual Report of the Ontario Department of Mines. The capitalization of the company is $100,000, and the officers are: president, Dr. D. A. Coon, Elgin, Ont.; vice-president, Albrecht Hasselbring, Flint, Mich.; secretary and treasurer, C. G. Walton, Elgin, Ont.; directors, William S. Myhill, Worthington, Ont., and H. A. Coon, Calgary, Alta.

As the vein of feldspar is on the south shore of Upper Rock lake at a point where no road is available in the summer, it was decided to transport the spar to the railway across a chain of lakes. Accordingly, a trestle and tramway, 940 feet long, was built from the vein to the shore of Upper Rock lake; a dam was constructed between Upper Rock lake and Lower Rock lake to hold the water in the former; the creek connecting Upper Rock and Stonehouse lakes was dredged out, and a canal dug between Stonehouse and Little Stonehouse lakes. At Little Stonehouse lake the spar will be unloaded from two scows carrying six tons each and lifted to the railways cars on the company's siding. This siding is on the Toronto-Ottawa line of the Canadian National Railways at a point 69.5 miles west of Ottawa. When this preliminary work had been completed the demand for feldspar suddenly ceased, and work had to be stopped in September. C. G. Walton of Elgin was superintendent.

The writer took a sample of this feldspar, which is white in colour, and the analysis obtained by the Provincial Assayer was as follows:—silica, 70.74 per cent., lime 0.68 per cent., soda, 2.96 per cent., potash, 10.46 per cent.

Vanluven.—Loughborough township, concession XII, west half of lot 3. On this lot Albert Vanluven of Holleford, Ont., had six men at work during December and part of January, 1922, prospecting a vein of feldspar which outcrops on the shore at the east end of Fourteen Island lake.

Verona Mining Company.—In Monteagle township, concession VII, lot 18, this company, a subsidiary of the Pennsylvania Feldspar Company, Philadelphia, Pa., has been for the past two years, quarrying feldspar near Hybla, Ont.

When last inspected in October, 1921, the pit on the Peter McDonald farm had the following approximate dimensions:—330 feet in length, 32 feet in width and 18 feet in depth. The vein strikes S. 75 degrees E. and is in a dark green gneiss with light-colored bands. All drilling is done by hand.

At one point in this vein in an area about two feet wide and six feet long, a highly radio-active mineral occurs. This portion of the vein contains feldspar, quartz (considerable of which is smoky), titanite, a black mineral (euxenite?), and a brownish black mineral; the last two minerals, whose composition has not been determined, seem to carry the radium.

The company has also done a small amount of work on the adjoining Sutherland farm.

The officers of the Verona Mining Company are:—president, S. Harry Worth; secretary and treasurer, M. Moore; general superintendent, G. V. Baker; resident superintendent, Walter B. Couch, Hybla, Ont., foreman, John Moran, Hybla, Ont. The head office of the company is at 404 Harrison Building, Fifteenth and Market Streets, Philadelphia, Pa.

Fluorspar

Wallbridge.—On the west half of lot 1, concession I, Madoc township, the Wallbridge brothers did considerable trenching and sank three prospect pits during 1921. On May 22, 1922, a two-compartment shaft was started on one of the fluorspar veins discovered during the previous year's prospecting operations, and when the property was visited on June 23, the shaft was 27 feet in depth with seven feet of fluorspar in the bottom and about 80 tons on the dump.

Gold

Cobalt Frontenac.—The Cobalt Frontenac Mining Company, Limited, owns about 1300 acres of mining land in Lennox and Addington county. The mine, formerly known as the Golden Fleece, is on Lots 24 and 25, concession VI, Kaladar township.

There are two inclined shafts on the property. The south shaft is 80 feet deep, with 90 feet of lateral work at the bottom. The north shaft, 400 feet from the south shaft, is 100 feet deep, with 350 feet of lateral work at the bottom. A winze, 68 feet in depth has been sunk from the 100-foot level.

The cyanide addition to the mill was completed early in 1922. The mill has an estimated capacity of 150 tons every 24 hours and includes a 14 by 24-inch jaw crusher, 10 stamps, a 5 by 16-foot tube mill, a Dorr duplex classifier, one 12 by 32 thickener, three 20 by 14 agitators followed by three 12 by 32 thickeners. The company owns and operates its own hydro-electric plant on the Skootamatta River. The power plant has a rated capacity of 600 horse power.

The officers of the company are:—Noah Dyment, Guelph, president; M. E. Fletcher, Hamilton, vice-president; D. H. Fletcher, Flinton, general manager.

Ore Chimney.—The Ore Chimney Mining Company, Limited, has developed a waterpower on the Skootamatta river at O'Donnel's rapids, near Northbrook. Nine dams have been built, and the water has been raised 18 feet at the rapids. The river has been diverted through a power canal 400 feet long, and has a head of 55 feet. The penstock is a stave pipe, 240 feet in length and 7 feet in diameter, and at the lower end has a surge tank. The penstock will supply two Wm. Hamilton turbines of 625-horsepower each, and controlled by Woodward governors. The electric equipment will be supplied by the Canadian General Electric Company. One generator has been delivered, and the other purchased for delivery this coming winter.

The generators are 400-k.w., and will generate power at 2,200 volts, which will be stepped up to 6600 volts by three single-phase transformers, and transmitted three miles to a transformer house at the mine and stepped down to 550 volts for use in the mine and mill.

No mining has been done since 1917, but it is expected that some work will be done in 1922. A cyanide plant is being added to the mill.

The company is capitalized at $1,200.000, and has offices at Northbrook, Ont., and at 700 Main Street, Buffalo, N.Y. The officers are:—president and manager, Anson E. Fletcher, Northbrook, Ont., vice-president, Edward Zaremba, Buffalo, N.Y.; secretary and treasurer, S. G. Both, Northbrook, Ont.; directors, Anson E. Fletcher, Northbrook Ont.; Edward Zaremba, Buffalo, N.Y.; Edward Smith, Buffalo, N.Y.; S. G. McKay, K.C., Woodstock, Ont.; A. Bauer, Waterloo, Ont.; John M. Fletcher, Buffalo, N.Y.; A. E. Cumming, Buffalo, N.Y.; Fred Slater, Woodstock, Ont.; Charles Zinn, New Dundee, Ont.; Charles Siple, Woodstock, Ont.; F. E. Misener, Hamilton, Ont. C. N. Thompson, until recently at the Galetta lead mine, is mine captain and J. R. Mougin is mill superintendent.

Graphite

Black Donald.—The mine and mill of the Black Donald Graphite Company, Limited, at Whitefish Lake was in operation only for the first three months of 1921. Market conditions in the graphite industry did not improve sufficiently during the year to enable the company to resume operations.

During the three months 1500 tons of ore of an average grade of 65 per cent. graphite were mined. The new mill using the oil flotation process has a capacity of 12 tons per day, and produces a flake graphite with a 95 per cent. carbon content.

An average of 54 men was employed. The officers are:—R. F. Bunting, president and treasurer; R. A. Telfer, secretary; John Patno, superintendent.

Gypsum

Ontario Gypsum Company Limited.—This company operated mines and calcining plants at both Caledonia and Lythmore, and a plaster board mill at Caledonia. During the year 1921 work was carried on continuously at the mine, mill, and plaster board plant at Caledonia. Mining was confined to the second or 65-foot level, the work being principally to the east and north of the incline, with some work to the west. An average of 90 men was employed in the mine, mill and plaster board plant. John Renwick was mine foreman, L. V. Robinson, mill foreman, and H. Bonnell, foreman of the board plant.

At Lythmore the shaft was sunk to the second level (115 feet) and mining carried on for a short time at the 91-foot and 115-foot levels. Gypsum from the second level, being of the white variety, was shipped to Paris, Ont., for the manufacture of alabastine. The mill was in operation for a time on gypsum shipped from Caledonia together with gypsum mined from the upper bed of the Lythmore mine. An average of 25 men was employed under W. A. Parkhurst, superintendent and Jos. Marks, foreman.

A total of 84,765 tons of gypsum was taken from the Caledonia and Lythmore mines during the year 1921.

The officers of the company are:—president, Whitney G. Case. 36 Main St. Buffalo, N.Y.; vice-president, O. W. Whitby,, Paris, Ont.; secretary-treasurer, Robert E. Haire, Paris, Ont. In addition the following are directors:—Jas. R. Inksater, Paris, Ont.; W. G. Case, Buffalo, N.Y.; A. J. Parkhurst, Caledonia, Ont., general manager is Robert E. Haire, Paris, Ont., and general superintendent, A. J. Parkhurst, Caledonia, Ont. The head office of the company is at Paris.

Iron Pyrites

Sulphide.—The mine and chemical works of the Nichols Chemical Co., at Sulphide operated at reduced capacity during 1921.

The iron pyrites treated amounted to 13,800 tons, 1,000 tons of which came from the stock pile. Ore from underground came principally from the north vein on the fifth and sixth levels. During the year a winze, 120 feet deep, was sunk, from the sixth to the seventh level.

In the chemical works, nitric, sulphuric and hydrochloric acids were manufactured in reduced quantities.

An average of 85 men was employed. W. H. De Blois is manager.

Lead

A syndicate of Arnprior people, represented by C. N. Thompson, formerly of the Kingdon Mining, Smelting and Manufacturing Company, took an option on lots 1 and 2, Block A, Tudor township, adjoining the old Hollandia mine. After performing a small amount of work the option was allowed to lapse.

Frontenac.—The Frontenac lead mine near Perth Road has again changed hands, and is now owned by the Northern Lead Company, Limited, of which the president and managing director is J. B. Bell of 232 St. James Street, Montreal. Some prospecting work on the surface was done in 1921.

Kingdon.—The Kingdon Mining, Smelting and Manufacturing Company, Limited, at Galetta, Ont., operated continuously throughout the year 1921. Underground work was curtailed for a month at the last of the year owing to the erection of a steel head frame and changes in the surface works.

During the year 1921 mining was carried on at the second, third and fourth levels. Stoping was done between the second and third levels and between the third and fourth levels. Drifts on the third level were driven 88 feet to the east and 182 feet to the west making the faces 568 feet and 591 feet respectively from the main shaft. On the fourth level drifts were extended 378 feet to the east and 383 feet to the west and were at the end of the year 656 feet and 659 feet respectively from the main shaft. From a point on the fourth level 210 feet west of the main shaft a winze was sunk to a depth of 130 feet. A new level will be made at the bottom of the winze and connected with the main shaft.

In December 1921, a steel head frame, 68 feet high was erected at the main shaft by the Dominion Bridge Company of Montreal. A new Marsh hoist driven by a 90 horse-power motor was installed to handle a two-ton skip.

Underground the ore is dumped from mine cars into the skip. When hoisted the rock is dumped automatically upon a 2-inch Ross grizzly from which the under size goes to a 200-ton bin in the shaft house. The oversize is fed to a 12-inch by a 20-inch jaw crusher and thence to the bin with the undersize from the grizzly. Through a hopper the rock passes to a 24-inch endless belt which in turn delivers to an 18-inch endless belt set at an angle of 12 degrees. The latter belt is driven from a Ding magnetic pulley. Rock then passes to a second Ross grizzly set at ¾-inch and the undersize goes to a 175-ton mill bin. The oversize is fed to a 5-inch by 15-inch Sturtevant crusher and thence to the mill bin.

The following changes have been made in the mill:— trommels have been replaced by Mitchell vibrating screens (three-sixteenth-inch and three-thirty-second-inch with a one-half-inch to be added later); the oversize from the three-sixteenth-inch screen goes to rolls set at one-half-inch and thence to a bucket elevator for return to the main circuit; the undersize falls directly on the three-thirty-second-inch screen, and the oversize from this screen passes out as feed for a James automatic jig; the undersize from the three-thirty-second-inch goes to a settling tank and thence to a James sand and slime tables.

The head office of the company is at 314 Beaver Hall Hill, Montreal, Que. The officers of the company are:—president, Chas. M. Robertson, Montreal, Que.; secretary-treasurer, John J. Milne, Montreal, Que.; managing director, A. G. Munich, Montreal, Que.; C. H. Thompson was superintendent until October 30, 1921, when he was succeeded by R. R. Rose, Galetta, Ont. F. A. Warren was smelter superintendent.

An average of 110 men was employed during the year.

Mica

Acton.—In January, 1921, J. U. and C. J. Acton of Gananoque, began to prospect a mica showing in lot 3, concession IV, Sherbrooke township. The vein is alongside the Canadian Pacific railway and about half a mile east of Bolingbroke station. The surface rights of the property belong to one Dowdell and the mining rights to the Matheson estate.

When inspection was made on Februrary 17 five men were engaged in sinking a pit, which was then about twelve feet deep.

On April 27, 1921, Acton Mines, Limited, was incorporated with a capital of $100,000 presumably to work this prospect. The head office of the company is in Gananoque.

Howes and Folger.—During the summer, Harry J. Cain of Tichborne mined mica on a small scale from several shallow pits east of Eagle lake and about a mile and a half northwest of Tichborne. Some of these pits were on the farm of David J. Howes, lot 28, concession II, Hinchinbrooke township, and the others were on lot 27, concession II, Hinchinbrooke, one of the parcels of land owned by the Folger estate. All of the veins worked were narrow.

Lacey.—The Lacey mica mine near Sydenham, was worked during all of 1921 by the Loughborough Mining Company, Limited. This mine still contains large reserves of mica.

When the last inspection was made in September the westerly part of the main vein was being stripped in preparation for stoping. An 8¼ by 10-inch Canadian-Ingersoll-Rand hoisting engine, equipped with a drum and a winch head, is used in connection with a cableway and carrier to handle the material removed from this part of the vein. A force of 16 men was employed.

George W. McNaughton, Sydenham, Ont., is manager and Richard Smith, superintendent.

Molybdenite

American Molybdenites, Limited.—The only molybdenite deposit in the province on which any work was done in 1921 was the one at Wilberforce on the Irondale, Bancroft and Ottawa branch of the Canadian National Railways. The property is on lot 32, concession XV, and lot 32, concession XVI, township of Monmouth. The Molybdenum Products Company, Limited, completed a concentrating mill on the property in December, 1918, but did not mill much ore. All work was stopped in the spring of 1919.

American Molybdenites, Limited, was incorporated, May 2, 1917 with a capitalization of $1,000,000 to work the deposit. The head office of the company is at 42 Toronto Arcade, Toronto, and the officers are:—president, W. J. L. McKay, 466 West Marion Street, Toronto; vice-president, P. J. Dwyer, Toronto; secretary, J. J. Gray, Toronto; directors:—William Flavelle, Lindsay; A. W. Marsh, Niagara Falls, Ont.; A. J. Reid, Sheffield, Eng.; H. T. Bush, Port Hope, Ont. The new company began work in March, 1921, with a small force of men. Some portions of the deposit were open-cut, but most of the work consisted in making alterations in the mill.

Mr. Peters was manager until September, when W. E. T. Barton took charge. The post office address for the mine is Wilberforce, Ont.

Talc

Connolly.—In February, 1921, through the failure of Gilchrist and Company, of New York, the lease of the Connolly property, held by the Anglo-American Talc Corporation, Limited, reverted to the owners. A new company known as the Asbestos Pulp Company was formed. This company has a capitalization of 500,000 shares par value $1.00; 350,000 of the shares are common stock and 150,000 preferred. The officers of the company are: H. B. Hungerford, Belleville, president; A. Gelinas, Montreal, vice-president; P. McNiven Bennie, Belleville, secretary-treasurer.

Additions to the mill include a crusher, 12 inches by 15 inches, a dryer with a capacity of 50 tons per day, two Griffin mills, screens and new blow rooms. The treatment process of this company now includes a sifting and air-flotation plant at Belleville.

George H. Gillespie and Company.—The Gillespie talc mill at Madoc was idle during January and was operated during the remainder of the year, but not at capacity. Full production was resumed in May, 1922. L. Ashley is mill superintendent.

Henderson.—The new main hoisting shaft at this talc mine has been completed to the 200-foot level. The production of ore during the year was maintained at a rate sufficient to supply the requirements of the Geo. H. Gillespie Company. E. Phillips is superintendent.

Price.—The Price farm, being the east half of lot 15, concession XIV, Huntingdon township, was prospected during the early part of 1922 by H. B. Hungerford of Belleville. Three hundred and twenty-five feet of trenching was done, and in June a shaft was down 20 feet.

Metallurgical Works

Algoma Steel Corporation.—In 1921 the Algoma Steel Corporation's blast furnaces at Sault Ste. Marie ran as follows: No. 1 furnace, 319 days; No. 2, 205 days; No. 3, 278 days; No. 4 was idle all year.

The staff at the furnaces remains as before, viz.: James H. Bell, blast furnace superintendent; James Dale, assistant blast furnace superintendent, and Harry Hitchens, blast furnace master mechanic.

Canadian Furnace Company.—The blast furnace of the Canadian Furnace Company at Port Colborne was operated from the beginning of the year to April 24, 1921, and employed 160 men.

From ores imported from the United States 32,405 tons of pig iron was produced. In December the work of relining the furnace and stoves was begun.

The officers of the company are: president, F. B. Baird; first vice-president and treasurer, Harry Yates; second vice-president, C. A. Cowan; secretary, Frederick Slee; superintendent, G. J. Higgins.

Coniagas Reduction Refinery.—The refinery of the Coniagas Reduction Company, Limited, at Thorold worked throughout the year on the reduction of ores from the Cobalt mines and closed down at the beginning of 1922 for alterations. An average of 105 men was employed during the year. During the year 897 tons of ore, concentrates and residues were treated.

A new company, the Coniagas Alkali and Reduction Company, Limited, was formed in June, 1922, to operate the plants in which the following companies are interested: The Coniagas Reduction Company, the Niagara Alkali Company, of Niagara Falls, N.Y., and the Electro Bleaching Gas Company of Niagara Falls, N.Y.

The treatment of ores, concentrates and residues will be continued under a different system by which they will be treated as chlorides and not as sulphates. The blast furnaces, roasting department, bag houses, Cottrell treaters and arsenic refining plant will be replaced by chlorinating furnaces, condensers and stills. The cobalt wet department will be remodelled and continued.

One new furnace building of steel and concrete has been erected and will be ready for operation in September. The building is 44.5 feet by 17 feet and 37 feet high and will have a ground floor, one operating floor and three working platforms above.

The officers of the Coniagas Alkali and Reduction Company are: president, E. D. Kingsley; vice-president, Col. R. W. Leonard; treasurer, Maj. A. L. Bishop; secretary, J. J. Mackan; directors, A. Longwell, T. M. Hicks, J. T. Manson; works manager, F. S. Low; superintendent, D .A. Mutch.

Deloro Mining and Smelting Co., Limited.—The refinery at Deloro was operated during the year at reduced capacity on the ores, concentrates and residue from the Cobalt mines. The silver and arsenic departments worked continuously, but the amount of ore received was considerably less than in the preceding year. The stellite plant was worked at intervals according to the demand and the oxide plant was closed during the year.

Insecticide was manufactured in moderate quantities to establish the product on the market. Arsenate of lead and calcium arsenate were the principal products of this plant, which is operated by the Deloro Chemical Co.

An average of 100 men was employed.

The officers are: president, M. J. O'Brien; managing director, Thomas Southworth; general manager, S. B. Wright, Deloro; general superintendent, R. A. Elliott, Deloro; secretary-treasurer, F. A. Bapty, Deloro.

International Nickel Refinery.—The refinery of the International Nickel Company of Canada, Limited, at Port Colborne operated at reduced capacity from the beginning of the year to August 31. During the remainder of the year the nickel refinery department was operated intermittently.

During the company's fiscal year ending March 31, 1922, 2,716 tons of matte were treated from which, with the metal in process, there was obtained 6,301,000 pounds of blister copper and 3,061,000 pounds of metallic nickel. The palladium and platinum were shipped as concentrate to Bayonne plant, where the gold and silver were also extracted.

Alterations in plant and treatment have been under way during the past 18 months, and when completed will permit of a production of nearly four million pounds of nickel per month, which is almost double the present capacity. To produce this increase the three blast furnaces will be changed from the brick type to the water-jacket type. This change has already been made on one of the furnaces. As the use of the reverberatory furnaces have been discontinued, space is now available for the installation of more calcining furnaces. The capacity of each of the calciners is being doubled by the addition of another deck.

A steel frame building 340 feet by 90 feet is being erected for the production of electrolytic nickel, platinum, palladium, gold and silver. The plant will have a capacity of 400,000 pounds of electrolytic nickel and is expected to be in operation in September, 1922. The treatment of all the ores will then be completed here. The Bayonne plant has been dismantled.

An electric substation will also be erected and transformers installed to provide for an increase of 1,000 h.p. from the Hydro Electric system.

During the seven months of operating in 1921 the average number of men employed was 237, and during the remainder of the year about 100.

The officers at Port Colborne are: general manager, John More; assistant general manager, James Kemp; auditor, E. Lambert.

Ontario Smelters and Refiners.—Ontario Smelters and Refiners, Limited, operated at Welland from the beginning of the year to November 15 except during the month of August.

The residues which had previously been stocked on the property from mines at Cobalt were re-treated and produced cobalt oxide, nickel hydrate, nickel sulphate and insecticide.

A mining claim on Bass lake near the mouth of the Montreal river was operated for a time to procure cobalt ore. During the time the plant was in operation forty men were employed. The officers of the company are: president, Charles Edward Potter: directors, John F. Hickling, M. D. Jenkins, Albert Herbold and James Edward; manager, J. F. Hickling; secretary-treasurer, P. W. Dunbar, Toronto.

Steel Company of Canada.—The Steel Company of Canada, Limited, operated its furnaces at Hamilton at reduced capacity and, owing to the decrease in demand, the stock of pig iron was considerably increased.

"B" furnace, with a capacity of 375 tons per day, was worked during the whole year and "A" furnace, with a capacity of 200 tons, for three and a half months.

The company employed 140 men while both furnaces were in operation and an average of 90 during the balance of the time.

R. G. Wells is works superintendent, and H. G. Hilton superintendent of blast furnaces.

Quarries and other Excavations

A large number of stone quarries and pits for obtaining clay, sand and gravel were inspected during 1921. A list of these is given below by counties and districts, alphabetically arranged. A glance at this list will show how widely spread are these essential materials of construction. Speaking generally, there are few parts of settled Ontario where they do not occur in quantity sufficient to supply local demands, while in many places the deposits are large enough to be drawn upon for the needs of other localities within transportable distances.

In the extreme southwestern part of the Ontario peninsula, say in the counties of Kent, Essex and Lambton, the supplies of gravel suitable for road and construction work are scanty, and recourse is had to dredging in the bed of the St. Clair river, particularly the upper portions, for gravel and sand brought down by the currents from Lake Huron and deposited in the river as shoals and gravel banks. The interests of navigation require dredging to be annually carried on at Sarnia and Point Edward, and most of the material recovered there is coarse and of good quality, and in demand on both sides of the river. The extensive operations which have been carried on at these points have much reduced the accumulations of ages, and suggest the advisability of conserving the remaining supply as much as possible for use on the Canadian side.

The list does not comprise all the quarries and excavations operated in the Province but not only those actually visited and inspected during the year. It will be observed that a number of the counties are not included, it being found impossible to cover all the operations within the twelve months.

QUARRIES INSPECTED DURING 1921.

County or District.	Operator	Address	Location	Average No. Employees	Product
Algoma	Dominion Mines & Quarries, Ltd.	McLennan	East Neebish Island	45	Quartzite, coarse and screened.
"	Wright & Co.	Sault Ste. Marie	S.E.¼, S.½, lot 12, Con. II. Deroche	14	Quartzite.
Bruce	John S. Cook & Son	Wiarton	lot 7, Con XXIV., Amabel	..	Limestone.
"	Sam Vogan	Wiarton	Wiarton	..	Lime.
"	Hydro Electric Power Commission	Walkerton	Brant Twp	38	Crushed Limestone for cement.
"	Toronto Plaster Co.	Teeswater	Teeswater	16	Hydrated lime..
Carleton	E. D. Brule & Sons	Billings Bridge	Bank of Rideau Canal, Gloucester Twp	25	Crushed and screened limestone for roads and concrete.
"	Campbell & Williams	Bell's Corners	Nepean Twp	6	Sandstones for building purposes
"	Farmer Construction Co.	23 Lorne Ave., Ottawa	Vernon, Osgoode Twp	18	Crushed and screened limestone for roads.
"	Central Experimental Farm.	Ottawa	Ottawa	12	Road material for experimental Farm.
"	J. I. Garvock	136 Lewis St., Ottawa.	Cor. Willow & Preston Sts., Ottawa	12	Limestone.
"	Foster & Cram	278 Echo Drive, Ottawa	Bank of Rideau Canal, Gloucester Twp	8	Limestone.
"	Foster & Cram	278 Echo Dr., Ottawa.	City View Quarry	12	Crushed and screened limestone
"	Mahoney & Rich	83 Bank St., Ottawa.	lot 3, Con. II., Gloucester	16	Crushed and screened limestone.
"	City of Ottawa Improvement Commission	c/o Superintendent Fraser Bldg. Ottawa	Cor. Carlington Ave. and Le Breton St. Ottawa	20	Crushed and screened limestone Crushed and screened limestone
"	Ottawa Suburban Roads Commission	Thistle Bldg., Wellington St., Ottawa	lot 16, Con. II, Nepean (Acres Quarry)	20	Crushed and screened limestone.
"	Ottawa Suburban Roads Commission	Thistle Bldg., Wellington St., Ottawa	lot 3, Con. III, Gloucester	12	Crushed and screened limestone.
"	H. R. Robillard & Sons	195 Nicholas St., Ottawa	McLaren Quarry, Gloucester Twp	10	Limestones for building, crushed limestone and lime

QUARRIES INSPECTED DURING 1921—*Continued.*

County	Operator	Address	Location	Average No. Employees	Product
Carleton	A. G. Perley	155 McLaren St., Ottawa	Rideau Canal, Gloucester Twp.	12	Crushed and screened limestone for roads
"	Richardson & Henry	83 Bank St., Ottawa	Con. II, Nepean	10	Crushed and screened limestone for roads
Dundas	F. M. Eagleson	Winchester	Mountain Twp	20	Crushed and screened limestone for roads.
"	F. Milligan	Iroquois	Lot 1, Con. II, Edwardsburg	20	Crushed and screened limestone for County roads.
Essex	Brunner Mond Canada, Ltd.	Amherstburg	Lots 6, 7, 8, Con. I, Anderdon; Lots 2, 3, Con. II, Anderdon	29	Limestone for chemical works.
Frontenac	County of Frontenac	R.R. No. 1, Kingston	Con. II. Pittsburgh	10	Crushed and screened limestone
"	McGinnis & O'Connor	Portsmouth	Con. I, Pittsburgh	40	Crushed and screened limestone for roads
"	McGinnis & O'Connor	Portsmouth	lot, 3 Con. VI, Pittsburgh		Granite for roads.
"	Roddy & Monk (3 quarries)	Kingston	Kingston	9	Building and crushed limestone.
"	Robt. Wallace & Sons	Kingston	Kingston		Limestone for building.
Grey	Stewart Chalmers	Owen Sound	Owen Sound	3	Dolomite quarry, and lime kilns.
"	Davis & La Pierre	Owen Sound	Owen Sound	4	Limestone for building.
"	McPherson & Hicks	Owen Sound	Owen Sound	2	Limestone for building.
"	Alex. L. McKay	2 Brown's Ave Toronto.	Owen Sound	9	Limestone for building.
"	James Keeling	Owen Sound	Owen Sound	4	Limestone for building.
"	Oliver-Rogers Stone Co., Ltd.	Owen Sound	Owen Sound	14	Limestone.
"	City of Owen Sound	Owen Sound	Owen Sound		Limestone.
Grenville	Grenville Crushed Rock, Ltd.	Oxford Mills	lots 8 & 9, Con. IV, Oxford	65	Crushed and screened limestone for ballast.
"	Department of Public Highways of Ontario	c/o Resident Engineer, Gananoque	lot 28, Con. I, Augusta	24	Crushed and screened limestone for Provincial Highways.
"	Department of Public Highways of Ontario	Prescott	Windmill Point	24	Crushed and screened limestone for Provincial Highways.
"	W. J. Woodland & Co	Cardinal	lot 10, Con. I, Edwardsburgh	12	Crushed and screened limestone for roads.
Haldimand	County of Haldimand	c/o Road Superintendent, Hagersville	lot 5, Con. I, Dennis (Dunn Quarry)	14	Crushed and screened limestone for roads.

Haldimand	Hagersville Quarries, Ltd.	Hagersville	lot 13, Con. XIII, Walpole	27	Crushed stone for roads and concrete.
“	Hagersville Crushed Stone Co	Hagersville	S.W.½, lot 28, Con. I, Oneida	25	Crushed stone for roads and concrete.
“	Hagersville Contracting Co.	Hagersville	lots 13, 14, Con. XIII, Walpole	32	Crushed stone for roads and concrete.
“	Department of Public Highways of Ontario	c/o Resident Engineer, Cayuga	Quarry near Byng, Dunn Twp	2	Limestone.
“	John Webber, Sr	R.R. 9, Dunnville	lot 22, Dunn Twp	2	Limestone for roads and concrete.
Halton	Christie, Henderson Co., Ltd.	Kelso		24	Grey Lime.
“	S. H. Hurst	Limehouse.	lot 21, Con. V, Esquesing	4	Building stone.
“	D. Robertson & Co.	Milton		23	Lime and building stone.
“	Toronto Lime Co.	Limehouse		19	Lime and building stone.
Hastings	Canadian Marble Co., Ltd.	18 Toronto St., Toronto	lots 30, 31, East Hastings Rd., Dungannon Twp		Marble quarry.
	Canada Cement Co.	Belleville	Point Anne	..	Limestone for cement.
“	Thos. & Wm. Morrison	Bancroft	lot 24, Con. V. & VI., Wollaston.	30	Granite for monuments.
“	Point Anne Quarries	Point Anne	Thurlow Twp.	4	Limestone.
“	Paddock & McCrow	R.R. 4, Belleville	lot 24, Con. I, Thurlow	30	Crushed and screened limestone for roads.
“	Department of Public Highways of Ontario	c/o Resident Engineer, Napanee	lot 30, Con. II, Tyendinaga	24	Crushed and screened limestone.
“	Department of Public Highways of Ontario	c/o Resident Engineer, Napanee	lots 16, 17, Con. III, Thurlow	15	Crushed and screened limestone.
“	H. T. Routley	109 Lytton Blvd., Toronto	lots 14, 15, Con. I, Thurlow	23	Crushed and screened limestone.
“	Wm. Vearwith	Bancroft	lots 3, 4, 5, Con. VIII, Faraday	..	Lime.
Lanark	W. H. Cameron	Box 65, Carleton Place	Ramsay Twp.	5	Crystalline limestone for lime.
“	Jas. Bedard & P. Pauline	Perth	lot 26, Con. X, N. Elmsley	2	White Sandstone.
“	Robt. McIlvenna	Smiths Falls	S. Elmsley Twp.	5	Limestone for roads.
“	County of Lanark	c/o Road Superintendent, Perth	lot 24, Con. IX, Beckwith	..	Granite for roads.
“	County of Lanark	c/o Road Superintendent, Perth	lot 11, Con. XIII, Pakenham	12	Crushed and screened limestone.
“	Department of Public Highways of Ontario	c/o Resident Engineer, Carleton Place	lot 30, Con. VIII, Beckwith	15	Crushed and screened limestone.
“	Town of Smiths Falls	Smiths Falls	Smiths Falls	4	Limestone.
Leeds	Joshua M. Abrams	R.R. 1, Gananoque	lot 6, Con. I, Leeds	3	Syenite paving blocks and monuments
“	Mark Appleby	Gananoque	lots 5, 6, Con. II, Leeds		Granite paving blocks.

QUARRIES INSPECTED DURING 1921.—*Continued.*

County or District	Operator	Address	Location	Average No. Employees	Product
Leeds	City of Brockville	Brockville	Brockville	20	Granite and quartzite for roads.
“	Alex. C. Brown	Lyndhurst	lot 10, Con. IX, Leeds	3	Granite for monuments.
“	Robert Brown	376 Sparks St., Ottawa	lots 9 & 10, Con. IX, Leeds	5	Granite for monuments, etc.
“	G. H. Bryson	Brockville	lot 7, Con. II, Elizabethtown	12	Limestone.
“	Chisholm Wellage Co	Brockville (2 Quarries)	Con. I, Elizabethtown	20	Crushed and screened granite and quartzite for roads.
“	Campbell & Lattimore	Gananoque	W.½ lot 32, Con. IV, Pittsburgh.	30	Granite paving blocks, building and monumental stone.
“	R. Gordon	Gananoque	Con. I, Escott	15	Granite paving stones.
“	Town of Gananoque	Gananoque	Gananoque	..	Quartzite for roads.
“	Department of Public Highways of Ontario	Gananoque	(Henderson Quarry) Con. I, Leeds	..	Granite for roads.
“	Street & O'Brien	Gananoque	lot 6, Con. II, Leeds	17	Granite paving blocks.
“	W. Young	Brockville	Con. II, Elizabethtown	3	Granite for roads.
Lennox & Addington.	Patrick Bergin	Napanee	lot 19, Con. VII, North Fredericksburg	5	Limestone and lime.
“ “	County of Lennox and Addington	Bath	lot 23, Con. III, South Fredericksburg	10	Limestone for roads.
“ “	County of Lennox and Addington	Bath	lot 35, Con. I, Ernestown	25	Limestone for roads.
“ “	County of Lennox and Addington	Enterprise	lot 45, Con. IV, Camden	20	
“ “	Town of Napanee	Napanee	Con. VII, North Fredericksburg.	..	Limestone for roads.
Lincoln	J. H. Book	St. Anne's	lot 20, Con. IX, Clinton	11	Limestone for roads.
“	J. W. Bradley	Merritton	lot 17, Con. X, Grantham	12	Limestone for roads.
“	J. A. Miller	Smithville	S.½ lot 6, Con. IX, South Grimsby	15	Limestone for roads.
“	County of Lincoln	c/o Road Superintendent, St. Catharines.	lot 10, Con. III, North Grimsby (Grimsby Quarry)	14	Crushed and screened limestone for roads.
“	Department of Public Highways of Ontario	Jordan Village	lot 18, Con. V, Louth	..	Limestone
“	Queenston Quarry Co	St. David's		40	Crushed, monumental, sawed limestone.
Muskoka	Gravenhurst Crushed Granite Co., Ltd	Gravenhurst	Gravenhurst	6	Crushed gneiss.

Ontario	Department of Public Highways of Ontario	Washago	Rama Twp	55	Crushed gneiss
Oxford	American Cyanamid Co.	Beachville	lot 16, Con. III, Oxford N.	23	Crushed limestone for cyanide plant at Niagara Falls.
“	Beachville White Lime Co.	Beachville	Beachville	..	Stone, lime, agricultural lime.
“	Standard White Lime Co.	Guelph	Beachville, Guelph	40	High calcium, magnesium and Hydrated lime
Perth	St. Marys Cement Co.	St. Marys		60	Cement.
“	Thames Quarry Co.	St. Marys		25	Limestone.
Peterborough	Ontario Rock Co., Ltd.	Havelock	lot 7, Con. VI, Belmont	45	Crushed trap.
Prescott	Barry Construction Co.	Hawkesbury	lot 9, Con. III, West Hawkesbury	15	Crushed limestone.
“	Mooney & St. Denis	Vankleek Hill	McAlpine	12	Crushed limestone.
“	County of Prescott	St. Isidore de Prescott	S. Plantagenet Twp	10	Crushed and screened limestone for roads.
“	County of Prescott	Plantagenet Springs	lot 6, Con. VI, North Plantagenet (Winning Quarry)	17	Limestone for roads.
“	Fred Gamble & Co.	Lancaster	Lot 20, Con. I, Alfred (Quarry near Lefaivre)	12	Limestone for roads.
Prince Edward	County of Prince Edward	Picton	Con. II, Hallowell	16	Crushed limestone for roads.
“ “	County of Prince Edward	Picton	Con. II, Hillier	12	Crushed limestone for roads.
“ “	County of Prince Edward	Allisonville	Hillier	14	Crushed and screened limestone for roads.
Renfrew	J. McTierman	R.R.2, Arnprior	Lot 21, Con. IV., Torbolton	2	Limestone and lime.
“	William Markus, Ltd.	Pembroke		5	Building stone, crushed stone for concrete.
“	Jamieson Lime Co.	Renfrew	lot 5, Con. II, Horton	5	Crystalline limestone and lime.
“	Jamieson Lime Co.	Renfrew	Renfrew		Crystalline limestone and lime.
“	Town of Renfrew	Renfrew	Con. II, Horton	8	
“	Standard Chemical Co.	Eganville	Eganville	5	Lime for chemical plants.
Russell	MacDonald & Dibble	Rockland		..	Limestone.
“	Grant Bros.	Casselman	Con. VI, Cambridge	7	Limestone for roads.
“	County of Russell	Bourget	..Con. IV, Clarence	10	Crushed and screened limestoe for roads.
“	County of Russell	Embrun	lot 8, Con. VIII, Russell	10	Crushed and screened limestone for roads.
“	County of Russell	Casselman	Con. VI, Cambridge (Francoeur Quarry)	18	Crushed and screened limestone for roads.
Simcoe	Geo. Higginson & Son	Coldwater	lots 19, 20, Con. XII, Medonte	13	Crushed limestone.
“	Ontario Stone Corp.	Uhtoff	lot 10, Con. IV, North Orillia	27	Crushed limestone.
Stormont	County of Stormont	c/o Road Superintendent, Cornwall	lot 9, Con. III, Finch	25	Crushed limestone for road.
Victoria	Britnell & Co.	Burnt River	lots A, B, Con. VI, Sommerville	18	Crushed limestone.
“	Canada Lime Co.	Coboconck	Coboconk	12	Limestone and lime.

QUARRIES INSPECTED DURING 1921.—*Continued.*

County or District	Operator	Address	Location	Average No. Employees	Product
Victoria	Crushed Stone, Ltd	Kirkfield	lot 49, Con. IX, Eldon	38	Crushed limestone.
"	Toronto Brick Co.	Coboconk	Coboconk	15	Lime.
Waterloo	City of Galt	Galt	On Bank of Grand River	47	Crushed and screened limestone for city streets.
Welland	Township of Bertie	Ridgeway	Bertie Twp.	7	Crushed limestone for roads.
"	Township of Bertie	Ridgemount	Con. VIII, Bertie	5	Crushed limestone for roads.
"	Canada Cement Co.	Port Colborne	Port Colborne	22	Limestone for cement.
"	Township of Humberstone	Humbertone	lot 4, Con. I, Humberstone (near Sherkston)	8	Limestone for roads.
"	E. G. Law	Ridgeway	Bertie Twp.	11	Limestone for roads.
"	J. Pirson	Port Colborne	lot 5, Con. II, Wainfleet	45	Limestone for roads
"	Walker Bros	Thorold	lot 31, Stamford	22	Limestone for flux and paper making, crushed and screened limestone for roads.
"	County of Welland	c-o Road Superintendent, Welland	lots 3, 4, Con. I, Pelham	10	Limestone.
Wellington	Alabastine Co. of Paris	Elora	Nichol Twp.	35	Hydrated and agricultural lime.
"	Christie Henderson & Co.	R.R. 2, Puslinch	lots 1, 4, Con. I, Puslinch	45	Lime.
"	E. Harvey & Son	Rockwood	Rockwood	10	Limestone & lime.
"	Jas. A. Gow	Fergus	Fergus	6	Crushed limestone.
"	J. Maloney	R.R. 2, Puslinch	lots 34, 35, Front Gore of Puslinch	24	Crushed limestone for roads.
"	Ontario Reformatory	Guelph	Guelph Twp.	70	Crushed limestone for roads.
Wentworth	Township of Barton	Mount Hamilton	lot 13, Con. VI, Barton	12	Crushed and screened limestone.
"	Township of East Flamboro	Rock Chapel		7	
"	Canadian Construction Co.	Hamilton	lot 14, Con. VI, Barton	25	Crushed limestone.
"	Canada Crushed Stone Corporation, Ltd	Dundas	Dundas	130	Crushed and screened limestone and building stone.
"	Dufferin Construction Co.	305 Brass Bldg., Toronto	On Ancaster Hill	25	Crushed and screened limestone.
"	John Dorr	Ryckman's Corners	lot 13, Con. VII, Barton	7	Crushed and screened limestone
"	Gallagher Lime & Stone Co., Ltd	R.R. 2, Hamilton	lot 15, Con. V, Barton	5	Limestone and lime.
"	J. N. Middleton	Ancaster	Ancaster	..	Limestone
"	Jas. Marshall & Sons	R.R. 4, Hamilton	lot 14, Con. VI, Barton	..	Limestone and lime.

"	Department of Public Highways of Ontario	Sheffield	lot 5, Con. VII, Beverley	17	Crushed and screened limestone. for roads.
"	Department of Public Highways of Ontario	Rockton	lot 18, Con. IV, Beverley	..	Crushed and screened limestone for roads.
"	Township of East Flamboro	c-o Township Clerk, Waterdown	Con. II, E. Flamboro	..	Crushed limestone for roads.
"	Towland Construction Co.	Long Branch	lot 12, Con. III, E. Flamboro	30	Crushed and screened limestone.
"	County of Wentworth	c-o Road Superintendent, Hamilton	lot 17, Con. V, Saltfleet (Ferry's Quarry)	6	Crushed and screened limestone
"	County of Wentworth	c-o Road Superintendent, Hamilton	lot 6, Con. IV, W. Flamboro	7	Crushed and screened limestone
"	County of Wentworth	c-o Road Superintendent, Hamilton	lot 1, Con. III, E. Flamboro (near Waterdown)	14	Crushed and screened limestone.
"	County of Wentworth	c-o Road Superintendent, Hamilton	Con. VIII, Barton	12	Crushed limestone.
"	Wentworth Quarry Co., Ltd.	Vinemount	lot 4, Con. V, Saltffeet	18	Crushed and screened limestone

CLAY PITS INSPECTED DURING 1921.

County.	Operator.	Address.	Location.	Average No. Employees.	Product.
Brant	Jackson Bros	Brantford	Brantford	..	Brick.
Bruce	Geo. Bannerman, Jr	R.R. 1, Greenock	lots 19, 20, Con. XIV, Culross	9	Brick and tile.
"	Smith Bros	Port Elgin	Port Elgin	6	Brick.
"	Samuel Wilson & Sons	R.R. 2, Paisley	lot 35, Con. II, Bruce	..	Brick and tile.
Carleton	Merkley's, Limited	Ottawa	Billings Bridge, Gloucester	.. 34	Red brick, shale brick, tile terra cotta and wall tile.
Essex	Ben Broadwell & Son	R.R. 3, Cottam	lot 12, Con. IV, S. Gosfield		Brick and tile.
"	John T. Miner & Son	R.R. 2, Kingsville	lot K, Con. III, S. Gosfield	..	Brick and tile.
"	Windsor Brick & Tile Co.	R.R. 3, Cottam	Con. VI, N. Gosfield	..	Brick, tile, building blocks.
Grey	Meaford Brick Co., Ltd.	9 Toronto St., Toronto	lot 9, Con. I, St. Vincent	14	Shale pit. .
"	Owen Sound Brick Co., Ltd.	Owen Sound	Owen Sound	..	Brick.
"	John C. Wright	Proton	lot 190, Range II, S.W.T. & S. Road, Artemesia	..	Brick and tile.
Halton	Atlas Brick Co.	Milton Heights	Trafalgar Township	..	Brick.
"	Milton Pressed Brick Co.	Milton	Milton	12	Brick.
"	Halton Brock Co.	Terra Cotta	lot 28, Con. II, Esquesing	18	Brick.
"	Hinde & Philips	Georgetown	Pt. lot 28, Con. II, Esquesing	5	Brick.
Hastings	D. W. Rollins	R.R. 4, Belleville	Thurlow Twp.	4	Red Brick.
Kent	J. Fox	Dresden	Con. III, Gore of Camden Tp.	8	Brick.
"	D. G. McGregor	R.R. 2, Dresden	Con. IV, Gore of Camden	3	Brick and tile.
"	H. W. Parks	Dresden	Con. IV, Gore of Camden	6	Tile.
"	Geo. J. Fox	Box 243, Dresden		5	Red Brick.
Lanark	T. Godfrey & Son	Carleton Place		3	Red Brick.
Lennox & Addington	John Chapman	R.R. 3, Napanee	lot 15, Con. VI, North Fredericksburgh	5 ..	Brick and tile.
Middlesex	J. M. McLoughlin	1044 William St., London	Victoria and Adelaide Sts., London	3	Yellow brick.
"	J. C. Waide	1010 Adelaide St. W., London	Adelaide and Cheapside, London	3	Yellow brick.
"	Warwick Brick Works	647 Grosvenor St., London	West side Elliott St., London	12	Yellow brick.
Peel	Interprovincial Brick Co.	Cheltenham	lot 29, Con. V, Chinquacousy	4	Brick.
"	Alsey Norton	Bolton	lot 8, Con. VII, Albion	..	Tile.
"	Streetsville Brick Co.	Streetsville	lot 3, Con. V, Toronto	5	Brick.
"	Milton Pressed Brick Co.	Streetsville		5	Brick.

Peterborough	Curtis Bros.	Box 949, Peterborough	lot 32, Con. XII, Duoro; Con. XII, Otonabee	24	Red and yellow brick and tile
Prescott	Edwin G. Steele	Vankleek Hill	Part lots 9 & 10, Con. IV, and lot 11, Con. IV, W. Hawkesbury	15	Brick.
Renfrew	Dochart Brick, Tile & Terra Cotta Works	Arnprior	1 mile west of Arupmior	25	Brick, etc.
Russell	Glascow & Mulligan	Russell	Near Russell	12	Red pressed brick.
Simcoe	Coldwater Brick & Tile Co.	Watson Bros., Orillia lessees	Coldwater	..	Brick and tile.
Waterloo	Ott Brick & Tile Co.	Kitchener	Kitchener	15	Yellow brick and tile.
Wentworth	W. H. Cooper	Dundas St., Hamilton.	Dundas St., Hamilton	2	Brick.
"	Canadian Pressed Brick Co.	Sun Life Bldg., Hamilton	lots 1 & 2, Con. IV, Barton	4	Brick.
"	Bartonville Pressed Brick Co.	Sun Life Bldg., Hamilton		5	Brick.
"	Dominion Sewer Pipe & Clay Industries, Ltd.	Aldershot	Aldershot	13	Brick, sewer pipe, tile, and clay products.
"	Hamilton Pressed Brick Co.	Hamilton	Hamilton	5	Brick, sewer pipe, tile, and clay products.
"	Geo. E. Mills	Hamilton	Dundas Road, Hamilton	4	Brick.
"	Ontario Sewer Pipe Co.	Aldershot	Aldershot	10	Sewer pipe, tile, and clay products.
York	Don Valley Brick Co.	Toronto	Don Valley	37	Brick.
"	Price & Smith	Toronto	Greenwood Ave	4	Brick.
"	Standard Brick Co.	Toronto	Greenwood Ave	4	Brick.
"	Sun Brick Co.	Todmorden	Don Valley	7	Brick.
"	Toronto Brick Co.	Swansea	Swansea	2	Brick.
"	A. H. Wagstaff	Toronto	Greenwood Ave	4	Brick.

SAND AND GRAVEL PITS INSPECTED DURING 1921.

County or District	Operator	Address	Location	Average No. Employees	Product
Algoma	Wright & Co.	960 Queen St., Sault Ste Marie	S.W. ¼ of S.W. ¼ Sec. 13, Korah	..	Gravel.
Brant	County of Brant	c-o Road Superintendent, Brantford	lot 1, Con. VI, Burford (Bishopsgate)	..	Gravel.
“	County of Brant	c-o Road Superintendent, Brantford	lot 29, Con. III, S. Dumfries	..	Gravel.
“	County of Brant	c-o Road Superintendent, Brantford	lot 10, Con. X, Burford	..	Gravel.
“	County of Brant	c-o Road Superintendent, Brantford	lot 6, Con. IV, Oakland (Church's Pit)	..	Gravel.
“	City of Brantford	Brantford	lot 7, Con. III, Oakland (Grantham Pit)	..	Gravel.
“	Brantford Sand and Gravel Co.	12 Temple Bldg.,	lot 20, Con. III, Brantford	..	Sand and gravel.
“	J. T. Burrows	Brantford	Brantford	..	Sand and gravel.
”	P. Clancy	Centre St., Brantford	Brantford	..	Sand.
”	Johnson Bros	Market St., Brantford.	Echo Place	..	Sand.
“	W. Isenbach	64 Darling St., Brantford	Brantford Twp	6	Sand.
“	Paris Sand and Gravel Co.	R.R. 2, Paris	lot 34, Con. III, S. Dumfries	12	Sand.
“	Town of Paris	Paris		..	Gravel.
Bruce	County of Bruce	Port Elgin	lot 49, Con. A, Greenock	..	Gravel for roads.
“	Samuel Wilson & Sons	R.R. 2, Paisley	lot 35, Con. VIII, Bruce	..	Gravel.
“	Chas. W. Cottrill	R.R. 2, Paisley	lot 18, Clyde St., Greenock Gore	..	Gravel.
“	Thomas R. Collins	Paisley	Paisley	..	Gravel.
“	Mrs. Thos. Dobson	Paisley	Paisley	..	Gravel.
“	James S. Dewar	Paisley	Paisley	..	Gravel.
“	Peter Meyer	R.R. 1, Greenock	lot 35, Con. I, S.D.R., Greenock	..	Gravel.
“	Duncan McArthur	R.R. 2, Paisley	Lot 11, Con. XX, Greenock	..	Gravel.
“	Vincent Leeson	Paisley	Paisley	..	Gravel.
“	Department of Public Highways of Ontario	Walkerton	Lot 35, Con. I, South Greenock	..	Gravel.
“	Smith Bros	Port Elgin	Port Elgin	..	Gravel.

Bruce	John Stoddard	Paisley	Paisley	..	Gravel.
"	William Wangler	R.R. 4, Walkerton	Lots 6, 7, Con. I South, Brant	..	Gravel.
"	Andrew Zettler	R.R. 4, Walkerton	Lot 20, Con. I North, Brant	..	Gravel.
"	Joseph J. Zettler	R.R. 4, Walkerton	Lot 19, Con. II North, Brant	..	Gravel.
Carleton	Fred Carss	R.R. 1, Arnprior	Lot 23, Con. IV, Fitzroy	..	Sand and gravel.
"	Jas. E. Blain	R.R. 1, Arnprior	Lot 22, Con. IV, Fitzroy	4	Sand and gravel.
"	Township of March	c-o Township Clerk, Stittville	Lot 20, Con. III, Huntley (Humphrey's Pit)	..	Sand and gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, Renfrew	Lot 27, Con. IX, Huntley	12	Sand and gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, Carleton Place	Lot 11, Con. VIII, Goulburn	6	Gravel.
"	Department of Public Highways of Ontario	Carleton Place	Lot 5, Con. I, North Gower (Mitchell Pit)	20	Gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, ways of Ontario	Lot 27, Con. IV, (Wallace Pit)	11	Crushed and screened gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, Carleton Place	Lot 16, Con. III, North Gower (Brownlee Pit)	10	Sand and gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, Carleton Place	Lot 3, Con. II, Nepean (Howe's Pit—)	18	Gravel.
"	County of Carleton	c-o T. H. Byrne, Road Superintendent, Sparks St., Ottawa	Lots 4, 5, Con. IV, Marlborough (Crawford Pit) Lot 30, Con. IV, Gloucester	20 6	Gravel. Gravel.
"	W. J. Donaldson	Arnprior, R.R. 1	Lot 27, Con. III, Fitzroy	..	Sand and gravel.
"	S. R. Rudd	Arnprior	Lot 27, Con. III, Fitzroy	..	Sand and gravel.
"	J. A. Harvey Spratt	R.R. 1, Billing's Bridge	Gloucester Twp	..	Sand and gravel.
"	John Stanley	Stanley's Corners		..	Sand, tile and concrete blocks.
"	St. Jean Bros	Clarkston, via Ottawa	East of Rockliffe Park, Gloucester	..	Sand.
Dundas	J. E. Faulkner	Morewood	Lot 15, Con. X, Winchester	2	Concrete blocks and tile.
"	J. Dagenais	Morewood	Lot 25, Con. XII, Winchester	..	Sand and gravel.
"	S. Fulton	Chesterville	Lot 9, Con. V, Winchester	..	Sand and gravel.
"	Geo. Forrester	Morewood	N½ Lot 15, Con. XI, Winchester	..	Sand and gravel.
"	J. A. McLean	R.R. 1, Chesterville	Lot 9, Con. VII, Williamsburg	..	Sand and gravel.
"	Thos. Featherston	R.R. 1, Chesterville	Lot 2, Con. VII, Williamsburg	..	Sand and gravel.

SAND AND GRAVEL PITS INSPECTED DURING 1921:—*Continued.*

County	Operator	Address	Location	Average No. Employees	Product
Dundas	C. Marcelis	R.R. 2, Chesterville	Lot 21, Con. VIII, Williamsburg	..	Sand and gravel.
"	Township of Williamsburg	c-o Township Clerk, Williamsburg	Williamsburg	..	Sand and gravel.
Elgin	C. A. Cascadden	R.R. 5, Aylmer	Lot 22, Con. VI, Malahide	..	Sand and gravel.
"	County of Elgin	c-o Road Superintendent, St. Thomas	Lot C, Con. VII, Aldborough	..	Gravel.
"	County of Elgin	c-o Road Superintendent, St. Thomas	Lot 2, Con. IV, Yarmouth	..	Gravel.
"	J. M. Hale	Aylmer	Lot 16, Con. V, Malahide	8	Gravel.
"	Township of Malahide	Aylmer	Lot 21, Con. VI, Malahide	..	Gravel.
"	Norman Griswold	R.R. 3, Iona Station	Lot 19, Con. VI, Dunwich	..	Sand and gravel.
"	McColl Bros	Rodney	Lot C, Con. VI, Aldborough	..	Sand and gravel.
"	D. McAlpine	Dutton	Lot 11, Con. A, Dunwich	..	Sand and gravel.
"	E. Learn	R.R. 5, Aylmer	Lot 19, Con. V, Malahide	..	Sand and gravel.
"	H. Newell	R.R. 4, Aylmer	Lot 35, Con. VIII, Malahide	..	Sand and gravel.
"	Jos. Axford	St. Thomas	Lot 7, Con. III, Yarmouth	..	Sand and gravel.
"	A. E. Ponsford	605 Talbot St., St. Thomas	Lot 17, Con. VIII, Yarmouth	..	Sand and gravel.
"	F. C. Poole	R.R. 4, St. Thomas	Lot 4, Con. VI, Yarmouth	..	Sand and gravel.
"	E. M. Prior	R.R. 4, St. Thomas	Lot 16, Con. IV, Yarmouth	..	Gravel.
"	Geo. Shelley	R.R. 4, St. Thomas	Lot 3, Con. VII, Yarmouth	..	Gravel.
"	Township of Yarmouth	c-o Township Clerk, St. Thomas	Lot 7, Con. IV, Yarmouth	..	Gravel.
Essex	County of Essex	c-o Road Superintendent, Sandwich	Lot 12, Con. III, S. Gosfield	..	Sand and gravel.
"	County of Essex	c-o Road Superintendent, Sandwich	Con. II, Mersea	..	Sand and gravel.
"	J. H. Hillman	Leamington	Con. II, Mersea	....	Sand and gravel.
"	Township of Mersea	Leamington	Con. II, Mersea	..	Sand and gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, Kingsville	Lot 1, Con. I, Mersea	..	Sand and gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, Kingsville	Lot 12, Con. III, S. Gosfield	..	Sand and gravel.
"	Township of South Gosfield	Kingsville	S. Gosfield Twp	..	Sand and gravel.
"	Windsor Sand and Gravel Co	Leamington	Mersea Twp	7	Crushed, washed and screened gravel; sand.

Frontenac	Kingston Sand and Gravel Co	R.R. 5, Kingston	Lot 34, Con. V, Kingston	7	Sand and gravel.
"	R. G. Johnson	Sunbury	Lot 7, Con. VI, Storrington	..	Sand and gravel.
"	Twp. of Storrington	R.R. 1, Sunbury	Lot 10, Con. VI, Storrington (Sloane Pit)	4	Gravel.
Grey	John J. Carson	R.R. 2, Proton Station	Lots 183, 184, R. III, S.W.T.S.R., Artemesia	..	Sand and gravel.
"	Israel McInnis	R.R. 4, Owen Sound	Lot 8, Con. III, Derby	..	Sand and gravel.
"	Gilbert Martindale	R.R. 5, Owen Sound	Lot 17, Con. III, or IV, Derby	..	Gravel.
"	William Legate	Owen Sound	Con. II, Derby	..	Sand.
"	S. Robert Lee	R.R. 3, Owen Sound	Lot 17, Con. IV, Derby	..	Gravel.
"	George Moore	R.R. 3, Proton Station	Lot 184, R. I, S.W.T.S.R., Artemesia	..	Gravel.
"	Johnson Nelson	Owen Sound.	Lot 10, Con. II, Derby	..	Sand and gravel.
"	Department of Public Highways of Ontario	Durham	Lot 184, R. I, S.W.T.S.R., Artemesia	..	Gravel.
"	John E. Russel Co	Durham	Durham	50	Crushed, washed and screened gravel; sand.
Kent	Township of Howard	Ridgetown	Lot 84, Howard Twp	4	Sand and gravel.
"	Township of Harwich	Blenheim	Lot 13, Con. VI, Harwich	..	Sand and gravel.
"	Township of Harwich	Blenheim	Lot 9, Con. II, Harwich	..	Sand and gravel.
"	Township of Harwich	Blenheim	Lot 16, Con. XII, Harwich	..	Sand and gravel.
"	Township of Harwich	Blenheim	Lot 7, Town Line, Harwich	..	Sand and gravel.
"	Township of Harwich	Blenheim	Lot 22, Con. VII, Harwich	..	Sand and gravel.
"	County of Kent	c-o Road Superintendent, Chatham	Lot 13, Con. IV, Harwich	..	
"	Department of Public Highways of Ontario	c-o Resident Engineer, Kingsville	Lot 10, Con. II, Harwich	..	Sand and gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, Kingsville	Lot 17, Con. VI, Harwich	..	Sand and gravel.
"	Department of Public Highways of Ontario	c-o Resident Engineer, Kingsville	Lot 84, Talbot Rd., Howard	6	Sand and gravel.
"	Township of Raleigh	...Charing Cross	South Cedar Springs, Raleigh Twp	..	Sand.
"	Township of Romney	c-o Township Clerk, Wheatley	Romney	..	Sand.
Lanark	James V. Closs	R.R. 1, Lanark	Lot 11, Con. X, Drummond	..	Sand, cement, tile.
"	A. Hammond	R.R. 1, Carleton Place.	Lot 2, Con. XII, Lanark	..	Sand.
"	Mrs. Elizabeth Gillespie	Perth	Lot 5, Con. I, Drummond	..	Sand.
"	Jas. Gibson	R.R. 3, Perth	Lot 16, Con. I, Bathurst	..	Sand.
"	W. J. McColl	R.R. 1, Carleton Place.	Lot 2, Con. XI, Lanark	..	Sand.

SAND AND GRAVEL PITS INSPECTED DURING 1921.—*Continued.*

County	Operator	Address	Location	Average No. Employees	Product
Leeds	Scott & Nicholson	Brockville	Lot 2, Con. I, Yonge	8	Sand and gravel.
Lennox & Addington.	Horace G. Denyes	R.R. 1, Odessa	Lot 16, Con. IV, Ernestown	..	Sand and gravel.
" "	Joy & Son	Napanee	Napanee	..	Sand gravel for cement, tiles, etc.
Middlesex	Edison Blizard	R.R. 6, London	Lot 2, Con. III, London	3	Gravel.
"	Builders Suppy Co	London	Cor. Elliott & Victoria Sts., London	..	Sand.
"	Henry Tack		Elliott St., London		Sand, concrete blocks.
Norfolk	County of Norfolk	Simcoe	Lot 7, Con. XII, Townsend	14	Gravel.
"	Township of Townsend	c-o Township Clerk, R.R. 1, Simcoe	Lot 16, Con. V, Townsend (Weir's Pit)	10	Gravel...
"	Township of Townsend	c-o Township Clerk, R.R. 1, Simcoe	Lot 8, Com. IX, Townsend (Klein's Pit)	4	Gravel.
"	Township of Townsend	c-o Township Clerk, R.R. 1, Simcoe	Lot 7, Con. IX, Townsend (Kellen's Pit)	3	Sand and gravel.
Northumberland	N. E. Bellyou	R.R. 4, Trenton	Lot 6, Con. I, Murray	..	Sand and gravel.
"	Town of Campbellford	Campbellford	Raglan St., Campbellford	12	Gravel.
"	P. L. McAuley	Trenton	Lot 5, Con. I, Murray	..	Gravel.
"	Henry Redden	Campbellford	Campbellford	..	Gravel for concrete.
"	T. H. Slush	River Road, Campbellford	Seymour Township	..	Sand and gravel.
Perth	McKnight Construction Co.	Stratford	Lot 4, Con. II, Ellice	..	Sand and gravel.
"	F. H. McKay	Stratford	Lot 8, Con. VI, Downey	..	Sand and gravel.
Peterborough	W. Brown	R.R. 4, Peterborough	Lot 1, Con. II, Smith	..	Gravel.
"	City of Peterborough	Peterborough	Smith Township	4	Crushed gravel.
"	Jas. Stothart	R.R. 4, Peterborough	Lot 7, Con. II, Smith	5	Crushed gravel.
Prince Edward	Township of Hallowell	c-o Township Clerk, Picton	Cheery Valley Road, Hallowell Twp.	..	Gravel.
" "	Town of Picton	c-o Town Clerk, Picton	Hallowell Twp	..	Gravel.
" "	West Lake Brick & Products Co.	R.R. 1, Westlake	Sand Banks, Yeo Lake	22	Sand Lime-Brick
" "	Homer White & Co.	Picton	Hallowell Twp	..	Sand and gravel.
Renfrew	County of Renfrew	c-o Road Superintendent, Pembroke	W½ Lot 16, Con. XII, Renfrew	14	Gravel.

Simcoe	Guy H. Orr	Coldwater	Lot 17, Con. XII, Medonte	..	Gravel.
"	The Sarjeant Co	Barrie	Barrie	..	Gravel.
"	J. G. Scott	Barrie	Barrie	..	Gravel.
Waterloo	Paul Bergman	Waterloo	Bridgeport	2	Sand and gravel, concrete tile.
"	Cowan Bros	R.R. 7, Galt	Cedar Creek Rd. and Waterloo Ave.	4	Sand and gravel.
"	J. Huffman	27 Pine St., Kitchener.	King St., Waterloo	..	Sand and gravel.
"	J. K. Forwell	26 Shoemaker Ave., Kitchener	Kitchener	..	Sand and gravel; concrete tile.
"	..Chas. Larter	76 Chalmers St., Galt.	Galt	..	Sand and gravel.
"	Sand and Supply Co.	Ayr		4	Sand and gravel.
"	F. S. Scott	Galt	North Dumfries Twp	1	Sand and gravel.
"	J. G. Scott	Barrie		..	Sand and gravel.
"	G. M. Shirk	Bridgeport	Waterloo Twp	5	Crushed and screened gravel.
"	A. Shoemaker	R.R. 4, Kitchener		..	Sand, concrete pipe.
Welland	Benson & Patterson	Stamford	Stamford Twp	8	Sand and gravel; moulding sand
"	Carroll Bros	Sherkston	On Lake Shore	10	Sand.
"	J. E. Crow	Ridgeville	Lot 5, Con. VII, Pelham	..	Sand and gravel.
"	Empire Limestone Co	Sherkston	On Lake Shore	8	Sand.
"	Jos. H. Fletcher	Ridgeville	Ridgeville	5	Concrete blocks.
"	Fonthill Sand & Gravel Co.	c-o C. E. McPherson. St. Catharines	Fonthill	3	Sand and gravel.
"	Edgar Metler	R.R. 3, Fenwick	Lot 12, Con. VII, Pelham	..	Sand and gravel.
"	Jacob Page	R.R. 3, Fenwick	Lot 12, Con. VIII, Pelham	..	Sand and gravel.
"	Township of Pelham	Fenwick	Pelham Township	5	Sand and gravel.
"	Ridgeville Concrete Works	Ridgeville	Lot 7, Con. VII, Pelham	3	Sand; concrete blocks.
Wellington	City of Guelph	Guelph	Edinborough Road and Bellevue St., Guelph	5	Gravel.
"	McNamara Bros. and Thornton	Herald Bldg., Guelph	Edinborough Road, Guelph	4	Gravel.
"	W. M. McAllister	Guelph	Victoria Road, Guelph	..	Gravel.
Wentworth	Armstrong Supply Co	326 Lister Bldg., Hamilton	Burlington Heights	8	Screened sand and gravel.
"	D. J. Bowman	97 Chesnut St., Hamilton		1	Sand and gravel.
"	Crawford Bros	King & Macklin Sts., Hamilton	King & Macklin Sts., Hamilton	7	Brick, sand and gravel.
"	Hamilton Sand and Gravel Co	Queen & York Sts., Hamilton	Burlington Heights	4	Sand and gravel.
"	Frid Bros	Macklin St. and Dundas Road, Hamilton	Macklin St. and Dundas Road, Hamilton	7	Brick, sand and gravel.
"	F. R. Ollman	Macklin St., Hamilton	Macklin St., Hamilton	6	Brick, sand and gravel.

SAND AND GRAVEL PITS INSPECTED DURING 1921.—*Continued.*

County	Operator	Address	Location	Average No. Employees	Product
Wentworth	L. Taylor	R.R. 1, Bartonville	Saltfleet Township	1	Sand and gravel.
“	W. Theaker	Kenilworth and Aberdeen Aves., Bartonville	Kenilworth and Aberdeen Aves., Bartonville	7	Concrete blocks.
York	Township of Saltfleet	c-o Township Clerk, Stony Creek	Lot 31, Con. III, Saltfleet	4	Sand and gravel.
“	Allen Bros	60 Birch Ave., Toronto	Lot 31, Con. A, Scarboro Twp	......	Brick, sand and gravel.
“	Joseph Bennet	145 Caledonia Road, Toronto	Scarlet Road, West Toronto	4	Sand and gravel.
“	M. S. Boehm & Co	13 Humber Rd	Mount Dennis	1	Sand and gravel.
“	W. Eillen	219 Scarlet Rd., West Toronto	Lot 7, Con. III, York	3	Sand and gravel.
“	Home Smith Estate	14 King St. E., Toronto	Lot 7, Con. III, York	2	Sand and gravel.
“	Thos. Forbear	Maple	Lot 22, Con. III, Vaughan	3	Sand and gravel.
“	Maple Sand, Gravel and Brick Co.	Maple	Lots 21, 22, 23, 24, Con. III, Vaughan	3	Sand and gravel.
“	W. Maher	846 Keele St., Toronto.	Mount Dennis	2	Sand and gravel.
“	C. Smyth	477 Runnymede Rd., Toronto	Scarlet Road, West Toronto	2	Sand and gravel.
“	York Sandstone Brick Co.	Toronto	York Township	5	Sand-lime brick.
“	York Sand and Gravel Co.	Toronto	York Township	8	Sand and gravel.

INSTRUCTION CLASSES FOR PROSPECTORS

By W. L. Goodwin

Introduction

Having been instructed by the Minister of Mines to organize classes for prospectors in selected centres in Ontario, the writer began on November 22nd, 1920, to make the necessary preparations, including collection and breaking up of minerals and rocks for specimens. In the basement of the Parliament Buildings were found materials which supplied about fifteen mineral species. About twenty were obtained from Queen's University through the courtesy of Professors G. J. McKay and E. L. Bruce. A few species were collected in the field and the remainder, making a set of 48 minerals and four rocks, were bought from Ward's Natural Science Establishment, Rochester, N.Y. The work of breaking up this material was so far advanced early in December that it was found possible to begin at Madoc on December 7th. After closing the class there, on December 21st, the preparation of the outfit was continued and completed by January 8th.

Methods Adopted

Classes were held in twelve places:—Madoc, Sault Ste. Marie, Port Arthur, Fort William, Sudbury, Haileybury, Swastika, Kirkland Lake, South Porcupine, Timmins, Elk Lake, and North Bay, covering the time from December 7th, 1920 to June 2nd, 1921. In each place the work consisted of two parts: a class for the determination of minerals by field tests, and a course of eight lectures on the Elements of Geology. The study of minerals was necessarily confined to daylight hours, but the lectures on geology were given in the evening. For the study of minerals, the material was distributed in small pieces to each member of the class. After determination, the occurrence, value, uses, etc., were discussed, and then printed descriptive labels were distributed, in which the specimen could be wrapped and kept for future reference. In this way it was found possible to study forty-eight minerals and several rocks, in the ten days allotted to each place. In addition to some four or five typical rocks, which were used in all the places, I found it possible, particularly in the northern gold fields, to do useful work with the rocks peculiar to the neighbourhood. The day class in each place had nine or ten sessions of about an hour and a half each.

The evening lectures were developed into a logical course on the Elements of Geology, illustrated by lantern slides, the object being to lay the foundation for more systematic study and the better understanding of reports as they are issued by the Geological Survey of Canada and the Ontario Department of Mines. These are quite generally studied by prospectors and there were frequent expressions of the helpfulness of the lectures in this connection. Eight lectures were given in each place, with the exception of North Bay, where it was thought advisable to shorten the time for both classes. It is to be noted that the evening lectures were attended by many who were not free to leave their work during the day, and by others who had a purely intellectual interest in the subject. It was felt that something was being done in this way to stimulate a more general and intelligent interest in mineral industries. To this end the lectures were always used, when possible, as a means of conveying information about the ore deposits of Ontario.

Attendance at Classes

The mineral classes were attended not only by prospectors, but by others interested in mineral industries. Some of these will become prospectors. In order to enlarge the horizon of the prospectors, a good deal of attention was paid to minerals that are not being particularly looked for. For example, samples of tin-stone were distributed everywhere, and, as soon as the material could be obtained, tinstone in the peculiar granite in which it is usually found was shown, and large specimens left in each locality, either in the Mining Recorder's office, or in some other place agreed upon.

A good deal of work was done in the indentification of minerals brought in by members of the classes. For this purpose a blowpipe set was added to the outfit. The meetings of the classes were always prolonged by work of this kind, and by consultation with the prospectors and others looking for information and advice. Where the numbers were large this made a long and busy day.

In the following tabular statement "Registration" refers to the total number attending the class for the study of minerals. Under "Average Attendance" are given numbers obtained by actual count in the case of the minerals class, and by as close an estimate as possible for the evening lectures on geology. In each place there were prospectors and others who were unable to attend the day class. Others were in the field, but had friends or partners attending the class. For such cases sets of the samples were made up when asked for. A record was kept and the numbers are given in the column "Extra Sets of Minerals." The sets of those who attended only part time were also made complete. In this way seven hundred and twenty-four complete sets of fifty-five specimens each were distributed.

Place	Date	Registration	Average Attendance		
			Minerals	Geology	Extra sets of Minerals
Madoc	Dec. 7—21	60	36	29	5
Sault Ste. Marie	Jan. 11—22	110	81	81	20
Port Arthur	Jan. 25—Feb. 4	30	23	34	15
Fort William	Feb. 7—17	38	22	60	20
Sudbury	Feb. 23—Mar. 5	21	14	49	15
Haileybury	Mar. 8—18	47	32	76	20
Swastika	Mar. 21—31	26	16	70	13
Kirkland Lake	Apr. 4—14	28	18	89	25
South Porcupine	Apr. 18—28	44	24	56	25
Timmins	Apr. 30—May 11	60	35	74	20
Elk Lake	May 14—25	30	15	73	16
North Bay	May 27—June 2	15	6	17	21
Totals		509	332	708	215

The low average attendance at the day class is to be explained by the fact that many of the prospectors did not join the class until a day or two after it was started. In some cases, too, members of the class had to break off before the end, owing to change of shift, having assessment work to do, and other causes. In some cases the news did not reach them until the class was well along. In nearly all places the class grew almost to the end. The local newspapers gave effective help by editorial notices and reports of progress as the classes went on.

Madoc

By arrangement with Reeve Burns the classes were held in the village hall. In addition to the local prospectors the classes were attended by several who came from considerable distances—one from Bancroft. By request an extra class was carried on for the Model School teachers and older students. While this extension of the work was not sought, it was not refused in any place where asked for. It will increase the interest in the study of minerals, and may help to keep up the supply of prospectors. Mr. Geo. H. Gillespie, and Mr. A. H. Watson of the *North Hastings Review,* were of great assistance in organizing the class. I wish also to thank Rev. T. H. H. Hall, and Messrs. Chris. Henderson, Donald Henderson, Wm. Cross, C. W. Wallbridge, George Lee, and Karl Stokloser for assistance in collecting minerals. The locality is particularly rich in minerals, and there are a number of keen prospectors at work there. Pyrolusite and bog manganese were brought in by members of the class and identified. Manganese ores in economic quantities are a possibility there. Through the kindness of Mr. Geo. H. Gillespie of G. H. Gillespie & Co., a large supply of talc was obtained. Mr. Robert Bryden, Manager of Canadian Industrial Minerals, sent me a box of selected fluorspar.

Sault Ste. Marie

The minerals class was held in the Board of Trade rooms, and I wish to thank the Secretary, Mr. W. E. Wolfe, for his hearty co-operation and assistance in organizing the classes. Mr. W. N. Miller, Mining Recorder, and Principal Rudlen of the High School were also very helpful. Mr. T. Taylor was engaged as assistant and his services were a considerable factor in making the work go smoothly and satisfactorily. Owing to the unexpectedly large numbers, it was found necessary to divide the day class, one section meeting at 10 a.m., and another at 2 p.m. By request a small class of graduates and advanced students of the High School was formed and I met them at 3.45 p.m. Each class was carried on for about an hour and a half. The evening lectures were held in the Carnegie Library. The very large attendance in the classes for identification of minerals introduced rather serious difficulties both in finding time for the long day's work and in eking out the supply of mineral specimens. The interest in prospecting had been stimulated by the discovery of gold near Goudreau lake, and the temporary closing down of the Algoma Steel works set free a number of prospectors working there for a grubstake, as well as many others who had made up their minds to go in for prospecting. The prospectors consulted me about a field class for the summer, asking if I or some other person could be sent by the Department of Mines to instruct such a class. I suggested that they should organize, draw up a petition, and forward it to the Minister. Forty members of the class expressed their intention of joining such a class, if it were organized. On invitation of the Rotary Club I addressed the members on the relation of the prospector to mineral industries. The Carnegie Librarian, Miss Carlyle, consulted me about books suitable for consultation and study by prospectors. Later I sent her lists supplied by W. G. Miller, and W. M. Goodwin.

Port Arthur

The city council provided quarters for the minerals class in the Ruttan building, and for the evening lectures in the council chamber, Whelan building. I engaged Mr. H. Watts as assistant. Mayor Matthews, Col. S. W. Ray, Col. Francis, J. W. Morgan (Mining Recorder), B. M. Wylie (Crown Timber Agent), and J. E. Marks gave aid and counsel in carrying on the class. I have to thank Mr. Marks for the loan of a valuable series of photographs taken in the interior of the Labrador country. Slides were made from these and used as effective illustrations in the geology lectures. Mr. F. Rodda, engineer of the Atikokan Iron Company, brought in a quantity of magnetite for use in the mineral classes, and F. Hille gave me samples of siderite and other iron ores for identification. A number of the prospectors brought in samples of molybdenite for identification. Mrs. A. S. Wink, Public Librarian of Port Arthur, wrote asking for a list of books suitable for prospectors. I sent her a list selected from those supplied by Dr. Miller and Capt. Goodwin. At the close of the classes prospectors and other citizens entertained me at lunch and invited me to speak on prospecting in relation to our mineral industries.

Fort William

Here the Board of Education provided a room for the minerals class in the Collegiate Institute and a lecture room in the fine new Technical School building adjoining. Principal E. E. Wood welcomed the classes very cordially and did much to make our work there pleasant and profitable. Mr. R. Cockburn acted as assistant. A number of keen and experienced prospectors make their headquarters in Fort William and Port Arthur. Some of those attending the classes were well acquainted with minerals. Both in Port Arthur and Fort William there is much interest in the development of an Ontario iron and steel industry using Ontario ores. Something might be done with the Atikokan and Mattawin ranges by uniting various interests and operating on a large scale. The Kiwanis Club invited me to an evening meeting to address them on our mineral industries. In connection with our iron ore resources, I ventured the opinion that we should develop processes and practice suitable to our own ores, rather than attempt to make our ores fit the established practice. Through the kindness of Dr. Oliver, Public Health Officer, I made an inspection of the Public Library, a fine building, which is used not only as a library, but as a community centre. The Librarian, Miss Black, showed me a large number of books suitable for prospectors. Very few additions are required to make a good consulting library for their purposes.

Sudbury

On the way to Port Arthur, I stopped off at Sudbury and in company with Mr. R. H. Hutchison, Principal of the Mining School there, made an examination of the possible places of meeting for the classes. It was decided that the most suitable places were those offered by the Board of Education, that is, for the day class, a room in the Mining and Technical School building, under construction, and for the evening lectures the assembly room of the High School. It was expected that the new building would be far enough advanced for this arrangement, but as the date for beginning in Sudbury was two weeks earlier than planned, I found that the room was in an unfinished state. However, the architect and contractor saw that it was made comfortable for us, and it turned out well. The building is particularly well lighted with windows, a good feature where minerals are to be examined. A number of prospectors living at Shining Tree did not see the change of date and so missed attending the class. Others had made arrangements which prevented them from coming at the earlier date. I engaged Jas. Cryderman as assistant. Some members of the class came from Copper Cliff, Shining Tree and Coniston. By request I attended a meeting of the Sudbury Branch of the Canadian Institute of Mining and Metallurgy and addressed them on the iron and steel industry. Much interest was taken in the classes by the staff of the High School, and I wish particularly to thank Mr. R. H. Hutchison of the Mining School for his assistance in organizing the class, and Mr. C. A. Campbell, Mining Recorder, for his willing and efficient help.

Haileybury

On arrival in Haileybury I had the valued assistance of the Mining Recorder, Mr. N. J. McAulay, in making arrangements for the classes. In conference with Mr. W. H. Tuke, Principal of the High School, a laboratory in the High School building was selected as the meeting place for the day class, and the assembly room was allotted to us for the evening lectures. Both were found very convenient and comfortable. Thanks are due Principal Tuke, Mr. James Hill of the Mining Department of the school, and other members of the staff. Here, as in some other places, the prospectors were a little slow in gathering, but finally they fairly crowded the small laboratory, many coming from Cobalt and New Liskeard and one from as far away as St. Thomas. The great majority of the class were experienced prospectors with considerable knowledge of minerals and rocks. In conversation with some of them I found that they had been studying text books like those of LeConte and Kemp. Mr. L. E. Hamilton, a student of the Mining School, assisted in the work of the classes. At the close of the Haileybury classes, it was arranged by correspondence with the deputy Minister of Mines that Mr. Hamilton should act as assistant to the end of the campaign. This arrangement worked out well, and Mr. Hamilton was thoroughly satisfactory.

At the close of the classes a Prospectors' Association was organized with Mr. James Hill of the Mining School as President, Mr. Train as Secretary-Treasurer, and Dr. W. L. Goodwin as Honorary President. At a banquet held a day or two later at which about eighty prospectors and mining men were present, the organization of the Temiskaming Prospectors' Association was completed, and the whole subject of prospecting in relation to mineral industries was thoroughly discussed. This discussion was made more valuable by the presence of a number of mine managers who could give the point of view of the investor. It would doubtless encourage prospecting and lead to more rapid development if there were some better connecting link between the prospector and the investor. Too often the prospector finds himself unable to continue in his chosen calling because he has reached the end of his means and has been unable to make a sale of claims. It is quite likely that further development of some such claims would show valuable results. What seems to be needed is some more systematic provision for development. Some better plan than the present rather haphazard way might be worked out by frank discussion at joint meetings of prospectors' associations with the Mine Managers' Association and similar bodies.

Swastika

This place was chosen on the request of a Prospectors' Association which has its headquarters there. We were met at the station by Mr. H. Geo. Ginn, Mining Recorder, Mr. T. M. Boisvert, President, and Mr. C. Billington, Secretary of the Prospectors' Association. Prospectors and others gathered in the evening in a room over Boisvert's store and I addressed them there. It had been the intention to start the class that afternoon, but as the train was several hours late, that was found impossible. A good start was made next day, the day class over Boisvert's store, and the evening lectures in the Union Church. Thanks are due Mr. T. M. Boisvert for the use of his room, to Messrs. Billington, Boisvert and others for assistance in fitting up the room and moving the apparatus from the station, to the Board of Management of the Union Church for the use of the church, to Rev. Jas. Lyttle for many kindnesses, including the use of his lantern, to the club of the local school for the use of their lantern, to Mr. T. A. McArthur, Inspector of Recorder's Offices, whose room in Swastika I occupied while there, to Mr. Ginn for the use of his office and for attending to the advertising, and to many friends for their unremitting efforts to make the class a success and our stay a pleasant one.

In this place as in others the number of men who have a good knowledge of minerals is noteworthy. This class was remarkable in having as one of its members, Miss Fetterly, an experienced practical prospector. On the evening of the last day in Swastika, we were very pleasantly entertained at a social gathering held in the Union Church.

Kirkland Lake

By arrangement with Mr. John Gillan the day class was held in the Miners' Union Hall, and it proved to be a comfortable and commodious classroom. The evening lectures were given in the Union Church (Rev. Jas. Lyttle, Pastor). To the officials of both Labor Union and Church, I wish to tender my best thanks. The day class here was attended by many experienced prospectors, including Miss Gertrude Oakes. Kirkland Lake is an unusually compact mining camp, which made it possible for the officials of a number of the mines to gather at the evening lectures. This made it very interesting for the lecturer, who wishes to embody in this report his appreciation of the compliment thus paid him and also of their warm hospitality. Mr. R. C. Coffey, Manager of the Lake Shore Mine, helped me collect samples of porphyry and lamprophyre and gave me a large specimen of telluride. This material was used at all the remaining places visited. Mr. Porteous, manager of the Hunton-Kirkland mine, gave me specimens of wolframite which were useful in the other places visited. A significant incident of our stay here was a visit from a Shining Tree prospector who wished to get information about the rocks and minerals characteristic of the Kirkland Lake area. He spent several days with us, and took with him a complete set of the mineral and rock specimens.

South Porcupine

On arrival at South Porcupine we were met by Mr. W. A. Donaghue, Mining Recorder, who had made all arrangements for hotel, place of meeting, etc. The classes were held in the Oddfellows' Hall, which proved quite satisfactory for the purpose. We made a visit to the Dome Mines, where we were pleasantly received by the General Manager, Mr. Depencier, who, with the Superintendent, Mr. Dowsett, showed us over the surface features, mill, etc. I have to thank Mr. C. E. Morgan for assistance in collecting mineral and rocks. We got supplies of greenstone, diabase, ankerite, quartz, porphyry and tourmaline (near Clifton mine). Mr. Offer, manager of the Clifton, gave us a considerable quantity of scheelite which occurs there. In organising the classes I had much assistance from Messrs. Donaghue, W. G. A. Wood (Crown Timber Agent) and Morgan. Here, as in other places, it was noticed that many of the prospectors were acquainted with a considerable range of minerals. Men attended from Dome Mines, Schumacher, and Pottsville. At a Board of Trade banquet held after the classes were closed, I was invited to speak on "Our Mineral Industries."

Timmins

By arrangement with Mayor McInnis and Councillor Longmore, the O.B.U. hall was secured for the day classes, and the Miners' Union hall for the evening lectures. The officials of the Unions gave us their hearty co-operation and assistance in preparing the halls for the work of the classes. The Timmins class was notable for the large number of active prospectors, some of whom came from considerable distances, two from Hearst. The hour for the day class was set to suit one of the mine shifts, as a considerable number of prospectors were working in the mines. Two prospectors told me of finding a large piece of float which corresponded with tin-stone samples distributed to the class. Afterwards they sent in samples which were tested and found to be tin-stone. By invitation we visited the Porcupine-Crown, Hollinger and McIntyre mines, and have to thank managers Stewart and Ennis, Mr. Webb, Manager of the Hollinger stores, and engineers Bell, Robinson and Longmore for making these visits pleasant and interesting. We collected supplies of quartz-porphyry and feldspar-porphyry. In all the classes held in the gold areas great stress was laid on porphyries by careful examination of specimens by the class, by definitions, and by microphotographs shown in the evening lectures. As porphyries are associated with the ore bodies in all our new gold fields, it was thought important for the prospectors to have clear ideas on that subject.

Elk Lake

The Council had selected as meeting places for the classes the council chambers for the day class and the school house for the evening lectures. Mr. M. R. Morgan, Mining Recorder, helped us make preparations for the classes and was kind enough to allow me the use of his office for writing letters, etc. I have also to thank Col. H. E. McKee, and Messrs. D. J. Giles, McKinley, and A. P. Campbell for assistance in collecting supplies of minerals and rocks from the Beaver, Silver Alliance, and Blight properties. Bornite, malachite, micaceous hematite, diabase, gabbro, and epidote were obtained. Mr. Frank Wescott gave me some pieces of very pure "kidney" hematite from his new discovery in Montrose? township. Many prospectors were noted on their way up the Montreal river to the Matachewan region. Large numbers were also going into Bruce township, and some claims were staked for gold in Midlothian township.

North Bay

Most of the prospectors who formerly made North Bay their headquarters have moved out, probably gone farther north. But it was thought worth while holding a class there as an experiment. While the attendance was small, the result in increasing the interest in exploration for minerals, was encouraging. Special stress was laid on the advisability of prospecting for minerals other than gold and silver, particularly those that might occur in granite and gneiss. By arrangement with Mayor Ferguson, the classes were held in the fine Normal School building, where Principal Casselman and his staff gave us every facility and made us very much at home. I have also to thank Messrs. Barry Shephard, G. Galvin, and C. G. Watson for many kindnesses, and much help.

General

If the many expressions of appreciation are taken as a fair indication of the value of this work, there can be no doubt about the advisability of continuing and elaborating it. The old days of prospecting by pure chance methods are passed. The prospector of to-day studies the geological maps and reports, and uses them intelligently. He is eager to enlarge his acquaintance with mineral species and rock formations, and to improve his methods by making them more scientific. Prospecting is becoming more and more a profession, in which, however, there will always be room for those of various degrees of scientific education. Advance in mineral industries depends primarily upon the prospector. If he stops work, there is no more progress. This only needs to be stated, and it at once follows that the profession of prospecting should be carefully nurtured, first by providing adequate facilities for education and second by such economic practice as will ensure a fair return to the prospector—a living wage. He invests his time, money and skill as the pioneer adventurer in mineral development.

Suggestions

At the present stage it does not seem possible to use the ordinary systems of education to meet the case of the prospector. In some way he should get the elements of chemistry and physics—just the essential ideas of these subjects, without the elaboration and detail of the ordinary textbook. This would be the foundation for the study of minerals and rocks, and the essentials of geology and ore deposits. All this can be done in winter, when prospecting is mostly held up. By means of summer field classes the prospector could be instructed in field geology, note-keeping and sketching. This should be done by instructors who are field geologists with some experience in prospecting. A great deal can be accomplished even in a few days of such instruction. The prospector needs only a start. He can be trusted to go on by himself. There are certain facilities for self-education which may be usefully provided. In a number of places where classes were held, the public librarian has adopted the idea of a prospectors' corner or section, where books and reports will be found specially interesting to prospectors. This movement should be encouraged, so that in every centre where prospectors make their headquarters they may count on finding the right books, maps, etc. In such places mineral and rock collections may be placed. These should be rather different from the ordinary collections—they should be particular and not general—illustrative of the rocks and minerals of the district. Special collections of gossans, stains, and other "signs," and minerals with their associated rocks, should be made, with the minerals they indicate—all so placed and described in large print that the student may be able to readily take in their meaning. Occasional illustrated lectures by members of the Department of Mines staff and others might be given in such places on subjects of current interest, for example on new discoveries of economic importance.

While it seems hardly possible to utilize the ordinary educational facilities, the mining schools in such places as Sudbury and Haileybury might be used in several ways. The collections mentioned could be housed there, the prospectors' classes and lectures might as a matter of course be held in the same place, and the teacher of geology in the mining school might be engaged to instruct field classes in the summer.

This is hardly the place to discuss the immediate return the prospector should get for his work. It is a very difficult subject, but those most interested should address themselves to it. The present conditions are hardly satisfactory. Many of the best prospectors are becoming discouraged. There is a good deal of chance in the business, and some scheme should be devised for carrying over those whose lucky strike is slow in coming.

Investment in prospecting is subject to the same uncertainties as are found in other business. The credit system is used in the latter and as the business goes on a living is taken out of it. The same idea applied to the independent prospector should in some way give him his living and enable him to go on until he made his strike.

In conclusion it is suggested that the places for holding classes should be selected at an early date so that the whole list with dates of beginning may be published in newspapers. This will enable the prospectors to arrange their business so as to reach the selected place in time.

Notes on Clays of the Missinaibi River[1]

By

Joseph Keele

Introduction

In a former report[2] certain clay deposits on the Mattagami river were called "Swamp Clays" as they were different from any of the late or post-glacial clays in the region. From the evidence obtained on the Missinaibi river the writer has no hesitation in assigning the so-called swamp clays on the Abitibi and Mattagami rivers to an interglacial age. The interglacial clays seen on these rivers were only very small remnants and at no place was the overlying late glacial boulder clay present, so that their true relation to the rest of the drift was not in evidence and hence the doubt as to their origin; but there is no doubt whatever about the interglacial age of similar materials on the Missinaibi river.

The yellowish sands and gravels included in the interglacial series have no economic value as they are subject to the same defects as all glacial sands, that is they are mixed with rock particles and glacial dirt of various kinds. These sands are not to be confused with those called yellow, orange and reddish sands described in the 1920 report.

Mesozoic Clays

Mesozoic clays and sands of Lower Cretaceous age were formerly widespread in northern Ontario, but a long period of pre-glacial erosion and two distinct glaciations in Pleistocene times have well nigh obliterated them, and now only small detached patches are found wherever the rivers have cut down through the overlying glacial debris deeply enough to expose them. The Mesozoic clay and sands on the Mattagami river were described in the report for the year 1920, but a much larger remnant than any of these occurs on the Missinaibi river. It is situated on the east bank of the river about 4 miles above the mouth of the Wabiskagami, and there is an outcrop of similar clays on the latter river which may be the continuation of the beds on the Missinaibi, as the outcrops are only two miles apart. These deposits are 45 miles north of the Canadian National railway line. The Cretaceous beds are exposed for a distance of half a mile along the bottom of the bank that in places rises to a height of 30 feet above the river. The greater part of the deposit is sand, mostly white, but stained in places to a pink and yellow colour, and a small quantity of white clay is mixed with the sand. The clay is of various colours, white, pink and yellow, but beds of mottled pink and white clay make up the bulk of the clay beds. The whole deposit is overlain by the late glacial stony clay, and some of this clay is pressed in and mixed with the Cretaceous clay for a depth of several feet. Two small streams which cut through the overlying glacial drift expose the lower clay and form convenient places for examining the deposit. The overburden of glacial clay is so thick that except on the immediate river bank it would be difficult to remove it for the economic working of the lower clay. The value of the deposit as a whole depends on the mottled clay and quartz sand. The mottled clay is a No. 3 fire clay and the sand would be suitable when washed for the manufacture of glass.[1]

---

[1] This short paper is a continuation of the report, under the same title and by the same author, which appeared in Volume XXX, 1921, Part I, pp. 171-175.

[2] Ont. Dept. Mines, Vol. XXIX, 1920, Part II.

A deposit of Cretaceous clay similar to the above was examined in 1899 by E. B. Borron, stipendiary magistrate, and the results were published in his report[2] to the Attorney-General of Ontario. The deposit was on the bank of Coal creek, a small stream entering the Missinaibi about 5 miles above the Wabiskagami river. Mr. Borron bored several holes in the clay and found 35 feet in thickness of black, pink, white and mottled clays and a bed of lignite—the whole underlain by a thick bed of white sand. This section is almost identical with the one found on the Mattagami river. This deposit was looked for by the writer but he was unable to find it. It appeared that the overlying clay had fallen and covered the exposures of Cretaceous clay and displaced the brook. Poplar trees nearly a foot in diameter are now growing on the former site of the outcrops.

---

[1] The results of the physical tests and chemical analysis of the clays and sand is given in the Summary Report of the Mines Branch, Dept. of Mines, Ottawa, 1920.

[2] Basin of the Moose River, published by Warwick & Sons, Toronto, 1890.

END OF PART X.

INDEX

Vol. XXXI, Part X

PAGE

A

Abitibi river, clay 95
Accidents, report on 1-10
Acres limestone quarry 71
Acton, C. J. 14, 66
Acton, J. U. 66
Acton Mines, Ltd. 14, 66
Adair, John 45
Addington co. *See* Lennox and Addington.
Agnew, John L. 24, 25
Agnew, N. J. 4, 14
Aikens, Berton A. 21
Alabastine Company of Paris 76
Aladdin Cobalt Co. 14, 44, 47
Albion tp., brick plant 78
Aldborough tp., gravel pit 82
Aldershot, brick plant 79
Alfred tp., limestone 75
Algoma Steel Corp. 4, 13, 21, 67
Algomont Mines, Ltd. 11, 22
Alini, W. 4
Allen, S. H. 12, 31
Allen Bros. 86
Allgeier, F. C. 25
Alpine Silver Mines, Ltd. 14, 57
Amabel tp., limestone 71
Amber mica. *See* Mica.
American Cyanamid Co. 75
American Molybdenite, Ltd. 14, 66, 67
Ames, G. C. 51
Analysis.
  Feldspar, Storrington tp. 62
Ancaster Hill 76
Anderdon tp., limestone 72
Anderson, A. J. 13, 22
Anderson, A. K. 12, 47
Anglo-American Talc Corp. 67
Angus, D. H. 12, 40
Argonaut Gold, Ltd. 12, 29
Armstrong, James A. 23
Armstrong Supply Co. 85
Artemesia tp.
  Brick plant 78
  Gravel and sand 83
Asam copper m. 22, 23
Asbestos Pulp Co. 15, 67
Ashley, James L. 24, 25
Ashley, L. 67
Asquith tp., gold mg. 45
Associated Goldfields Mg. Co. *See* Canadian Associated Goldfields.
Atikokan iron mine 13, 17
Atlas Brick Co. 78
Attalah, M. A. 12, 47
Auer, C. M. 39
Augusta tp., limestone 72
Austin, E. T. 27

PAGE

Averill, Chas. S. 39
Axford, Jos. 82

B

Babcock feldspar claim 59
Bache, J. S. 31
Baden tp., gold mg. 45
Badger, Harry S. 13
Bailey Silver Mines, Ltd. 14, 15, 47
Baird, F. B. 68
Baker, D. 30
Baker, G. Vaughan 63
Ball, S. 4
Bannerman, Geo. 78
Baptiste Lake, dolomite mine 11, 58
Bapty, F. A. 68
Barrie, gravel 85
Barry Construction Co. 75
Bartlett, James 1, 11
Barton, W. E. T. 14, 67
Barton tp.
  Brick plant 79
  Limestone quarries 76, 78
Bartonville 86
Bartonville Pressed Brick Co. 79
Bass l. 69
  See also Kirk g.m.
Bateman, G. C. 14, 15, 47, 50
Bathurst tp.
  Feldspar mg. 60, 61
  Sand pits 83
Beachville, lime kilns 75
Beachville White Lime Co. 75
Beard, James W. 25
Beatty tp.
  Gold mg. *See* Majestic Gold Mines, Ltd.
Beaumont Gold Mines, Ltd. 12, 31
Beckwith tp. granite quarry 73
Bedford tp. feldspar quarry 59-61
Bell, J. B. 14, 65
Bell, James H. 21, 67
Bell, J. Macintosh 14, 56
Bell, Thos. E. 4
Bellyou, N. E. 84
Belmont tp., trap quarrying 75
Bennet, Joseph 86
Benson and Patterson 85
Benton, James 60, 62
Bergin, Patrick 74
Bergonan, Paul 85
Bertie tp., limestone quarries 76
Beverley tp., limestone quarries 77
Bewick, Moreing & Co. 33
Bidgood Gold Mines, Ltd. 12, 40
Big Dyke Gold Mines, Ltd. 12, 31
Billings Bridge, brick plant 78
Billington, C. 91

PAGE
Birkett, E. H. 12, 21
Bishop, A. L. 48, 68
Bishop silver m. 58
Bishopsgate 80
Black, John 23
Black, John H. 39, 52
Black Donald graphite m. 13, 64
Blackwell, Walter 26
Blain, James E. 82
Blake, Charles E. 16
Blake, George J. 16
Blanche Bay Syndicate 12, 30
Blast furnaces. *See* Metallurgical works.
Blizard, Edison 84
Blood, Sir Bindon 44
Blue Quartz Gold Mines, Ltd. 12
Boehm, M. S. & Co. 86
Boisvert, T. M. 91
Bolingbroke 66
Bolton, A. J. 41, 42
Bonanza gold m. 12, 15
Bonnell, H. 64
Bonnin, Florence M. 28
Bonsall Mines, Ltd. 57
Book J. H. 74
Booth J. Fred. 24
Borden, Sir. Robt. 24
Borresen, Sir U. J. R. 24
Bousquet Gold Mines, Ltd. 12, 46
Bowzan, M. L. 13, 31
Bowman, D. J. 85
Bradley, J. W. 74
Braniff, Harry 42
Brant co.
  Gravel pits 80
  Tile and brick plant 78
Brant tps.
  Gravel and sand 81
  Limestone quarry 71
Brantford.
  Brick plant 78
  Gravel and sand 80
Brantford Sand and Gravel Co. 80
Brebner feldspar quarry 59
Brick and tile 78, 79
Bridgeport, gravel and sand 85
Brigham, A. F. 12, 34
British American Nickel Corp. 14, 24
Britnell & Co. 75
Britton, Arthur H. 33
Broadwell & Son 78
Brockville 74
Brown, Alex. C. 74
Brown, J. V. 60
Brown, Robert 74
Brown, S. M. 24
Brown, W. 84
Browne, K. C. 26
Brownlee gravel pit 81
Brownson, Willard H. 25
Brougham tp., graphite 64
Brouse, W. H. 52
Bruce, E. L. 87
Bruce co.
  Gravel pits 80, 81
  Limestone quarries 71
  Tile and brick plants 78

PAGE
Bruce nickel m. 14
Bruce tp.
  Brick plants 78
  Gold prospecting 93
  Gravel pit 80
Bruce Mines, Ltd. 27
Bryden, Robt. 89
Buffalo silver m. 4
Builders Supply Co. 84
Bull, George A. 21
Bullion gold m. 17
Bunting, R. F. 13, 64
Bupon, G. H. 74
Burford tp., gravel pit 80
Burke gold claims 12, 45
Burkell, R. B. 21
Burlington Heights.
  Gravel and sand 85
Burnip, F. W. 58
Burns, Mr. 89
Burns feldspar claim 61
Burns gold claims 39
Burnside gold m. 44
Burrows, J. T. 80
Burt, A. 44
Burton, Archie, S. 45
Bush, A. T. 67
Butchart, David 25
Byng, Dunn tp. 73
Byrne, J. J. 14

C

Cabana, Oliver 44
Cables, testing of 9
Caesar, Charles 27
Cain, Harry J. 14, 61, 66
Calcite 11, 59
Caldwell, Thos. B. 11, 59
Caledonia, gypsum 13, 64
Callinan, J. W. 39
Callinan-McKay Exploration Co. 39
Cambridge tp., limestone 75
Camden tp.
  Brick plant 78
  Limestone quarry 74
Cameron, Donald A. 59
Campbell, C. A. 90
Campbell, C. L. 17
Campbell & Lattimore 74
Campbellford, gravel pit 84
Campoli, L. 4
Canada Cement Co. 76
Canada Crushed Stone Corp. 76
Canada Lime Co. 75
Canadian Associated Goldfields, Ltd. 12, 29
Canadian Construction Co. 76
Canadian Furnace Co. 15, 67
Canadian Pressed Brick Co. 79
Cane tp., silver mg. 57
Cane Silver Mines, Ltd. 57
Carleton co.
  Brick plant 78
  Gravel and sand 81
  Limestone quarries 71, 72
Carlyle, E. J. 24

PAGE
Carmichael, A. 14, 28
Carrol Bros. 85
Carson, John J. 83
Carss, William 82
Cartwright gold m. 12
Cartwright Gold Fields, Ltd. 30
Cascadden, C. A. 82
Case, Whitney G. 64
Castle silver mine 58
Castle Mining Co. 58
Castle-Trethewey Mines, Ltd. 58
Cavanagh gold claim 39
Cavers, T. Willard 24
Cement.
  Limestone for 73, 75
Chambers-Ferland silver m. 14, 47
Chapman, John 78
Cheyne, James C. 28
Chinguacousy tp., brick plant 78
Chirico, Angelo 45
Chisholm Wellage Co. 74
Christopher, A. G. 55
Church's gravel pit 80
Cimetta, R. 4
City View limestone quarry 71
Clancy, R. 80
Clarence tp., limestone 75
Clark, E. B. 59
Clark, G. M. C. 51
Clarke, K. S. 27
Clarke, William D. 28
Classes. *See* Instruction classes.
Clay.
  Accidents in working 1-8
  Missinaibi r. 95, 96
Clemson, Dan 28
Clinton tp., limestone 74
Clobridge, Charles 62
Clobridge feldspar mine 11
Close, James V. 83
Cobalt, Bass l. 69
Cobalt A-53 silver mine 14, 48
Colbalt Frontenac Mining Co. 12, 63
Cobalt Reduction Co. 51
Cobalt silver area.
  Mining reports 47-55
Coboconk, limestone quarrying 75, 76
Cochenour, William M. 30
Cochrane gold claims 45
Cockburn, R. 90
Coffey, R. C. 12, 41, 92
Cohen, Maurice 46
Coldwater 79
Coldwater Brick & Tile Co. 79
Cole, G. E. 1, 11
Coleman tp.
  See Cobalt silver area; Hyland silver m.
Collier, A. H. 56
Collier, H. H. 48
Collins, Charles 26
Collins, F. Howard 14, 57
Collins, Thomas R. 80
Collins silver mine 14, 57
Concrete products.
  List of producers 71, 84-86
Coniagas Alkali and Reduction Co. 68

PAGE
Coniagas Mines, Ltd. 4, 14, 48, 68
Coniagas Reduction Co. 15, 68
Coniston nickel-copper smelter 27
Coniston quartzite quarry 27
Conkey, M. J. 45
Connolly talc mine 15, 67
Contact Bay Mines, Ltd. 12, 15
Coon, Dr. D. A. 62
Coon, H. A. 62
Cooper, Fred. 41
Cooper, W. H. 79
Cope, Francis E. 23
Copper.
  See Algoman Mines Ltd.; Jewel Gold & Copper Mg. Co.
Copper Cliff.
  Nickel. *See* International Nickel Co.
  Smelter 26
Corey, W. E. 25
Corkill, E. T. 25
Corless, C. V. 27
Corning, Fred. G. 31
Corundum 11, 59
Corundum, Ltd. 11, 59
Costello gold mine 12, 29
Cottrill, Charles W. 80
Couch, Walter B. 12, 63
Cowan, C. A. 68
Cowan Bros. 85
Cowie, Geo. S. 22
Craig, Ernest 40
Craig, George R. 26
Craigmont 11
Crain, James 59
Crawford Bros., brick works 85
Crawford gravel pit 81
Creighton nickel mine 4, 14, 25, 26
Cromwell, William N. 25
Crosby, A. B. 40
Crow, H. C. 30
Crow, J. E. 85
Crown Reserve Mg. Co. 12, 30
Crumble, J. A. 49
Crushed Stone, Ltd. 76
Cryderman, Jas. 90
Crystalline limestone.
  Details of quarries 73, 75
Culford, W. J. 4
Culross tp., brick plant 78
Culver, F. L. 40
Currie tp., waterpower 30
Curry, Daniel 41
Curry, N. 41
Curry, R. 41
Curtis Bros. 79
Czarina Gold Mines Co. 15

D

Daeschner, Wm. J. 20
Dagenais, J. 82
Daimpré, C. G. 12
Dale, James 67
Dalton, William H. 39
Danforth, Frank L. 28
Danhof, John J. 21
Davidson, G. M. A. 40
Davidson gold mine 13

PAGE
Davidson Consolidated Mines, Ltd. 38
Davies, O. 21
Davis, J. J. 38
Day, James E. 46
De Blois, W. H. 14, 65
Deloro Mining and Smelting Co. 4, 15, 68
Dempster, Thos. 49
Denison, Chas. L. 42
Denker, C. T. 13, 40
Dennis tp., limestone 72
Denny, James J. 52
Denyes, Horace G. 84
De Pencier, H. R. 12, 31, 92
Derby tp., gravel and sand 83
Deroche tp.
  Iron mining 22
  Quartzite 71
De Rosa, Savario 45
Deschênes, Que. 24
Despard, W. H. 59
Dethloff, W. L. 27
Detroit Goudreau Gold Development Co. 12, 20
Dewar, James S. 14, 80
Dickenson, J. G. 54, 57
Dickson Creek (Cobalt) Silver Mines, Ltd. 14, 49
Dill quartz quarry 26
Dobson, Mrs. Thos. 80
Dochart Brick, Tile & Terracotta Wk. 79
Dodwell, Mr. 66
Dodworth, James R. 39
Dolomite 11, 58
Dome Extension gold mine 32, 33
Dome Mines Co. 12
  Accident at mine 4
  Mining report 31-33
Dominion Mines & Quarries, Ltd. 14, 55
Dominion Sewer Pipe & Clay Industries, Ltd. 79
Donaghue, W. A. 92
Donaldson, Oliver G. 44
Donaldson, S. 4
Donaldson, W. J. 82
Don Valley Brick Co. 79
Dore, Albert 4
Dorr, John 76
Downey tp., gravel and sand 84
Dowsett, C. W. 31, 92
Drummond tp., sand pits 83
Dufferin Construction Co. 76
Duffy, Charles G. 44
Duguette, Wilfred 29
Dumfries tps., gravel and sand .. 80, 85
Dunbar, P. W. 69
Dundas, limestone 76
Dundas co., stone quarrying .. 72, 81, 82
Dungannon tp.
  Marble quarry 73
Dunlap, David A. 34
Dunn tp., limestone quarry 72, 73
Dunwich tp., gravel and sand 82
Duoro tp., brick plant 79
Duval, Joseph C. 60
Dwyer, R. J. 67
Dycie, J. G. 28
Dye, Norman E. 14, 57

PAGE
Dye, R. E. 14, 47
Dyment, Noah 63

E

Eager, Frank J. 14, 27
Eagle l., Hinchinbrooke tp. 66
Eagle l., Manitou L. dist. 16
Earle, E. R. 52
Eastern Ontario, mining reports . 58, 86
Echo Place 80
Edwards, Gordon C. 59
Edwards, W. S. 31
Edwardsburg tp., limestone 72
Egan tp., gold mining 30
Eganville, limestone 75
Eldon tp., limestone 76
Electro Bleaching Gas Co. 68
Elgin co., gravel and sand 82
Elizabethtown tp., road material 74
Elk Lake, classes for prospectors 87, 88, 93
Elk Lake mg. dist., mining reports 57, 58
Ellice tp., gravel and sand 84
Elliott, R. A. 68
Elmsley tps., sandstone 73
Emens, W. H. 14, 54
Emery feldspar claim 11, 59
Emmons, Harold D. 16
Empey, W. F. 41
Empire Limestone Co. 85
Empress gold mine 15
Empress Gold Mg. Co. 16
Ennis, R. J. 13, 93
Erion, Edward R. 60
Erleigh, Viscount 27
Ernestown tp.
  Gravel and sand 84
  Limestone 74
Errington, Joseph 37
Escott tp., paving stones 74
Esquesing tp.
  Brick plant 78
  Limestone 73
Essex co.
  Brick plants 78
  Gravel and sand 82
  Limestone 72
Eureka Flint and Spar Co. 11, 59
Euxenite 61
Evans, D. Owen 27
Evans, R. E. 38
Evans, W. Arthur 46
Evered, N. J. 13
Explosive accidents 2-9

F

Fairlie, M. F. 14, 51
Faraday tp., limestone quarry 73
Fasken, Alex 31, 52
Fasken, David 52
Fatalities. *See* Accidents.
Faulkner, J. E. 82
Fawcett tp., gold mg. 45
Featherston, Thomas 82
Federal Feldspar, Ltd. 59
Federal Mining Co. 14, 18

PAGE

Feldspar.
  Mines, list of 11, 12
  Mining reports 59-63
Feldspar, Limited 11, 59
Feldspar Quarries, Ltd. 59
Fennell, Robert 38
Fergus, limestone 76
Ferguson, Harcourt 44
Ferry's limestone quarry 77
Felterly, Miss 92
Filmer, Arthur Wilson 38
Finch tp., limestone 75
Finucane, T. R. 31
Fitzroy tp., gravel and sand 81
Flamborough tp., limestone 77
Flavelle, William 67
Fletcher, A. E. 13
Fletcher, D. H. 12, 63
Fletcher, Jos. H. 85
Fletcher, M. E. 63
Fluorite 12, 63
Flux, limestone for 76
  quartz for. *See* Dill,
  quartzite for 27
Flynn, J. R. 18
Folger estate 66
Folger mica mine 14
Fonthill Sand and Gravel Co. 85
Forbear, Thos. 86
Forbes, D. L. H. 13, 42
Forbusch, Frank 39
Forest, W. L. 45
Forrester, Geo. 82
Fort William.
  Classes for prospectors at 87-90
Forwell, J. K. 85
Foster, Clement A. 20
Foster silver mine 51
Fourteen Island lake 62
Fox, Geo. J. 78
Fox, J. 78
Francis, Col. 89
Francoeur limestone quarry 75
Franz, W. C. 21
Fredericksburgh tps.
  Brick plant 78
  Limestone 74
Frid Bros. 85
Frontenac co.
  Gravel and sand 83
  Limestone quarries 72
  See also Bedford tp.
    Loughborough tp.
    Pittsburgh tp.
    Storrington tp.
Frontenac lead mine 14, 65
Frontier silver m. 14, 51
  See also Haileybury Frontier.
Fulton, S. 82

G

Galbraith tp., gold mg. 21
Galetta, lead mg. 65
Gallagher, Ziba 23
Gallagher Lime & Stone Co. 76
Galt, limestone quarry 76
  gravel and stone 85

PAGE

Galvin, G. 93
Gamble & Co., Feed 75
Ganonoque, road material 74
Gardner Feldspar Co. 11, 59
Garson nickel m. 14, 27
Gauthier, H. G. 39
Gauthier tp.
  Gold. *See* Argonaut Gold, Ltd.
Geissler, G. Cosby 20
Gelinas, A. 67
Gentles, Charles A. 45
Giaya, Italis 45
Gibson, Jas. 83
Giersten S. 24
Gilchrist & Co. 67
Gillan, John 92
Gillespie, Mrs Elizabeth 83
Gillespie, Everett 26
Gillespie, Geo. H. 15, 67, 89
Gillespie & Co., Geo. H. 15, 67
Gillies limit.
  Silver mining 48
    See also Oxford Cobalt.
Ginn, H. Geo. 91
Giroux I., silver mg. 47
    See also Oxford Cobalt.
Glascow & Mulligan 79
Glendinning, George 16
Glendinning, L. 4
Glendower 59
Globe, A. R. 39
Gloucester tp.
  Brick plant 78
  Gravel pits 81
  Limestone quarries 72
Gneiss quarries 74, 75
Godfrey & Son, T. 78
Gold.
  Mining accidents 1-9
  Mining reports 15, 20, 21, 63, 64
Gold island, Night Hawk l. 39
Goldale Mines, Ltd. 33, 50
Golden Fleece gold m. 63
Golden Summit Mg. Co. 30
Goluk, H. 4
Goodchild, W. H. 47
Goodwin, W. L.
  Report on Instruction Classes 87-94
Gordon, M. B. R. 11, 60
Gordon, R. 74
Gordon, W. A. 42
Gosfield tp.
  Brick plant 78
  Gravel and sand 82
Goudreau 28
Goudreau Gold Mines, Ltd. 20
Goudreau Superior Mg. Co. 21
Goulais r., iron mg. 13, 21
Goulburn gravel pit 81
Gould, Arthur ....
Gow, Jas. A. 76
Gower tps., gravel 81
Gowganda l. 57
Gowganda mg. dist.
  Mining reports 57, 58
Grace gold m., Eagle l. 16
Grace gold m., near Wawa l. 21
Graham, R. 40

PAGE

Graham, William T. ... 25
Grand r., limestone ... 76
Granite l., Fawcett tp. ... 45
Granite quarries ... 72, 74
Grant Bros. ... 75
Grantham, gravel pit ... 80
Grantham tp., limestone ... 74
Graphite.
  Brougham tp. ... 13, 64
  Silver islet ... 18
Gravel. *See* Sand and Gravel.
Gravenhurst Crushed Granite Co. ... 74
Gray, Charles N. ... 16
Gray, J. J. ... 67
Greco, Peter ... 47
Greene, Richard T. ... 52
Greenock tp., gravel ... 80
Grenet, Sam J. ... 39
Grenfell tp.
  Gold mg. *See* Blanche Bay Syn.
Grenville co., limestone ... 72
Grey Co.
  Brick plant ... 78
  Gravel and sand ... 83
  Limestone ... 72
Grierson, A. W. ... 40
Griffith, Sir E. J. ... 27
Grigg, John ... 27
Grimsby tp., limestone ... 74
Griswold, Norman ... 82
Gronningsaeter, A. ... 24
Gros Cap Mining & Exploration Co. ... 28
Gross, David ... 422
Grover, George ... 39
Grzybowski, Stanley ... 17
Guelph tp., limestone ... 76
Gull l., Lebel tp. ... 40, 42
Guntrip, H. J. ... 44
Guy, George J. ... 17
Gypsum ... 13, 64

H

Hadfield, Sir Robert ... 27
Haggerty, Richard ... 30
Haileybury.
  Instruction classes for prospectors ... 87, 88, 91
Haileybury Frontier silver m. ... 55
Haire, Robt E. ... 64
Haldenby, Charles N. ... 23
Haldimand co.
  Limestone quarries ... 72, 73
Hale, J. M. ... 82
Hall, Oliver ... 27
Hall, Rev. T. H. H. ... 89
Hallis, Sam ... 39
Hallowell tp.
  Gravel and sand ... 84
  Limestone ... 75
Halton co.
  Brick plant ... 78
  Limestone ... 73
Halton Brick Co. ... 78
Hamblin, W. H. ... 42
Hambly, George T. ... 40
Hambro, Sir Erie ... 24
Hamilton, L. E. ... 91

PAGE

Hamilton.
  Blast furnace ... 15, 69
  Brick plant ... 79
  Gravel and sand ... 85
Hamilton Pressed Brick Co. ... 79
Hamilton Sand and Gravel, Ltd. ... 85
Hammond, A. ... 83
Hands, Wm. J. ... 23
Hargrave silver m. ... 50
Harker tp., gold mg. ... 30
Harkness, James ... 55
Harris, J. G. ... 27
Harris, L. C. ... 31
Harris-Maxwell gold property ... 29
Harrison, Major D. B. ... 39
Hart, R. J. ... 48
Harvey & Son, E. ... 71
Harwich tp., gravel and sand ... 83
Hasselbring, Albrecht ... 62
Hastings co.
  Brick plant ... 78
  Limestone ... 73
Hattin, V. H. ... 42
Havilah gold mine ... 21
Hawkesbury tps.
  Brick plant ... 79
  Limestone quarry ... 75
Hawson, James ... 21
Hayden, Charles ... 25
Hayden, W. H. ... 12, 33
Hayden Gold Mines, Ltd. ... 12, 33
Hearst, W. I. ... 20
Heckscher, August ... 52
Henderson, Chris. ... 89
Henderson, Donald ... 89
Henderson & Co., Christie ... 76
Henderson granite quarry ... 74
Henderson talc mine ... 15, 67
Henley, E. S. ... 15
Hennessey, A. W. ... 48
Herbold, Albert ... 69
Hermo Mining Co. ... 54
Herschel tp., dolomite ... 58
Hetherington, F. E. ... 55
Hibbert, Ernest ... 24
Hickling, John F. ... 69
Hicks, T. M. ... 68
Higgins, G. J. ... 68
Higginson, Geo. & Son ... 75
Highways, Dept of
  Gravel quarrying ... 80, 83
  Stone quarrying ... 4, 74-77
Hlidreth, Andrew G. ... 39
Hill, James ... 91
Hill, Netter J. ... 21
Hille, F. ... 90
Hillier tp., limestone ... 75
Hillman, J. H. ... 82
Hills, W. H. ... 33
Hilton, H. G. ... 69
Himrod, William C. ... 42
Hinchinbrooke tp.
  Feldspar mining ... 62
  Mica mining ... 66
Hinde & Philips ... 78
Hitchens, H. ... 67
Hochstetter, Ralph ... 44

PAGE
Hodgson, F. J. ... 41
Hoisting cables, testing of ... 9
Holden, John B. ... 34
Hollands-Hurst, H. ... 14
Holleford ... 59
Hollinger Consolidated Gold Mines, Ltd.
Accident at mine ... 4
Burke claims worked by ... 12, 45
Operating report ... 34-36
Hologden Mines, Ltd. ... 12, 45
Holloway tp., gold mining ... 30
Home Smith Estate ... 86
Honsberger, H. S. ... 48
Hooper, E. ... 56
Hoppins feldspar mine ... 60
Hore, Reginald E. ... 46
Horton tp., limestone ... 75
Howard tp., gravel and sand ... 83
Howe, Homer H. ... 20
Howes, David J. ... 66
Howes gravel pit ... 81
Howry Creek area, gold mining .. 46
Howry Creek Mining Corp. ... 12, 47
Huffman, J. ... 85
Hugill, A. H. ... 21
Humberstone tp., limestone ... 76
Humphrey's gravel pit ... 81
Hungerford, H. B. ... 67
Hunt, Alex. D. ... 16
Hunter, Andrew W. ... 17, 45
Huntingdon tp., talc mg. ... 67
Huntington, W. Va., nickel plant ... 25
Huntley tp., gravel and sand ... 81
Huray, Stephen J. Le ... 50
Hurd, Ralph ... 42
Hurd, Walter E. ... 41, 42
Hurst, Philip ... 49
Hutchison, R. H. ... 90
Huth, Frank ... 41, 42
Hybinette, Victor ... 24
Hybla, feldspar quarry near ... 62
Hydrated lime ... 71, 75, 76
Hydro-Electric Power Commission.
Limestone quarry ... 71
Hyland silver mine ... 55

I

Ingolfsrud, L. J. ... 27
Inksater, Jas. R. ... 64
International Feldspar Co. ... 11, 60
International Nickel Co. 4, 14, 24, 68, 69
Interprovincial Brick Co. ... 78
Iron mining ... 11
Accidents ... 1-8
Reports ... 17, 21, 22
Instruction classes for prospectors 87-94
Iron pyrites. *See* Pyrites.
Isenbach, W. ... 80
Islet Exploration Co. ... 15, 18

J

Jackfish, gold mg. near ... 15
Jackson, A. H. ... 14
Jackson, Albert J. ... 28
Jackson, Wm. S. ... 16

PAGE
Jackson Bros. ... 78
Jackson Development Co. ... 12, 16
Jager, Oliver E. ... 24
Jamieson Lime Co. ... 75
Janica, A. ... 4
Jaretzki, Alfred ... 24, 25
Jebsen, Oscar ... 24
Jeffrey, R. T. ... 31
Jensen farm. *See* Golden Summit Mg. Co.
Jessup, Charles ... 46
Jewel Gold and Copper Mg. Co. .. 11, 23
Johnson, George ... 11, 23
Johnson, R. G. ... 83
Johnson Bros. ... 80
Johnston, Albert W. ... 42
Jones, James D. ... 15, 21
Jordan, C. F. ... 40
Jordan, F. S. ... 24
Jorgensen, C. R. C. ... 44
Joy & Son ... 84
Jupiter gold m. ... 38

K

Kakar, Andrew ... 9
Kaladar tp., gold mg. ... 63
Keays, James ... 61
Keays, William ... 60, 61
Kee, H. A. ... 33, 49
Keele, Joseph ... 95
Keeley Silver Mines, Ltd. ... 14
Report and photo ... 56
Kellen's gravel pit ... 84
Kemp, Charles H. ... 45
Kemp, James ... 69
Kennedy, H. G. ... 57
Kennedy, Murray D. ... 58
Kennedy, Robt. ... 21
Kenogami, gold mg. near ... 30
Kent, William ... 26
Kent co.
Brick plant ... 78
Gravel and sand ... 83
Kerr-Addison gold property ... 29
Kerr Lake Mines, Ltd. ... 14, 49
See also Goldale Mines, Ltd.
Killoran, B. G. ... 41
King, A. R. ... 4
Kingdon Mining, Smelting and Manufacturing Co. ... 65
King-Kirkland Gold Mines, Ltd. .. 12, 40
Kingsley, E. D. ... 68
Kingston, limestone ... 72
Kingston Sand & Gravel Co. ... 83
Kingston Smelting & Refining Co. .. 65
Kirk gold mine ... 12, 21
Kirkham feldspar mine ... 60
Kirkland-Combined Mines, Ltd. .. 12, 40
Kirkland Lake.
Classes for prospectors ... 87, 88, 92
Kirkland Lake gold area.
Mining reports ... 40-45
Kirkland Lake Gold Mg. Co. .. 4, 12, 40
Kirkland Lake Proprietary (1919), Limited.
See Burnside Gold Mines.
Tough-Oakes Gold Mines.

PAGE

Kitchener, gravel and sand 85
Klein's gravel pit 84
Knight, H. W. 33
Knight, J. J. 49
Korah tp., gravel pit 80
Kraft, Harry N. *See* Orser-Kraft.
Krakowiak, Thomas 17
Kramer, G. 4

L

Labelle, F. A. 29
Lacey mica mine 14, 66
Ladd, Clarence H. 21
Lahay, L. J. 46
Lake Shore Mines, Ltd. 12, 41
Lake Superior Corporation 21
Law, E. G. 76
Lawson, W. B. 24
Lawson tp., silver 58
Lambert, E. 69
Lanark co.
  Brick plant 78
  Gravel and sand 83
  Granite and limestone 73
Landagne gold claims 45
Langer, Dr. Carl 27
Langmuir tp., gold mg. 39
Langworthy, W. F. 16
Larder Lake gold area.
  Mining reports 29-31
La Rose Mines, Ltd. 14, 50, 51
Latilla, H. G. 44
Lead mining 14, 65
Learn, E. 82
Lebel tp., gold mg. 40, 42
Lee, George 89
Lee, S. Robert 83
Leeds co.
  Gravel and sand 84
  Stone quarrying 73, 74
Leeds tp.
  Granite 74
  Syenite 73
Leeson, Vincent 80
Lefaivre 75
Legate, William 83
Lennox and Addington co.
  Brick plant 73
  Gold mining 63
  Gravel and sand 84
  Stone quarrying 74
Leonard, R. W. 48, 68
LeSueur, R. V. 33
Leszcynski, Edward 20
Levack nickel mine 14, 27
Levy l. *See* Collins s.m.
Lewisohn, Adolph 49
Lightfoot, S. 28
Lightning River Gold Mines, Ltd. 12, 30
Limestone.
  Quarrying 71-77
    accidents 1-9
Lincoln co.
  Limestone quarries 74
Livingstone, G. Robert 20
Little Silver hill 53
Little Silver vein 53
Little Stonehouse l. 62
London, brick plant 78
London tp., gravel pit 84
Long lake, Frontenac co.
  Feldspar quarry 60
Longmore, ... 92
Longwell, Alex. 48, 68
Longworth, W. L. 16
Lorrain Operating Co. 55
Loughborough tp.
  Feldspar quarrying 60, 62
  Mica mining 66
Loughborough Mining Co. 14, 66
Louth tp., limestone 74
Lovelace, F. L. 40
Low, F. S. 68
Lower Rock l. 62
Lucy, Dr. R. 30
Lucy, William J. 30
Lycett, James 21
Lythmore, gypsum 64
Lyttle, Rev. Jas. 92

M

McAllister, W. M. 85
McAlpine, D. 82
McAlpine, Ont. 72
McArthur, Duncan 80
McArthur, T. A. 91
McAuley, N. J. 91
McAuley, P. L. 84
McCarthy, T. B. 25
MacCaskill, Donald 26
McColl, W. J. 83
McColl Bros. 82
McConnell, Ricardo 11, 60
McCrea, Charles 46
McDonald, J. 21
McDonald, John A. 23
McDonald, Peter 26
Macdonald & Dibble 75
Macdonald feldspar quarry 12, 62
Macdonald l., Asquith tp. 45
MacDonell, W. A. 27
McDougald, Wilfred L. 34
McGaughey, Charles S. 45
McGibbon, D. Lorne 50
McGregor, D. G. 78
McGregor feldspar mine 59
Machin, H. A. C. 13, 17
McInnis, Israel 83
McIntyre Porcupine Mines, Ltd. 13
  Accident at mine 4
  Mining report 37, 38
Mack, A. A. 41
Mackan, J. J. 48, 68
McKay, Prof. G. J. 87
McKay, F. H. 84
McKay, J. A. 39
McKay, W. J. L. 67
McKellar, D. 16
McKellar, Peter 16
McKellar-Longworth gold m. 13, 16
McKerrow, William 28
McKnight Construction Co. 84

PAGE

McLaren, George R. 13, 22
McLaren limestone quarry 71
McLean, J. A. (Chesterville) 81
McLean, J. A. (Detroit) 11, 60
McLennan, Ont. 28
McLoughlin, J. M. 78
McMann, Robt. 28
McMillan, J. G. 1, 11
MacMurchy tp.
  Gold mg. *See* White Rock Mg. Co.
McNamara Bros. and Thornton 85
McNaughton, George W. 14, 66
McNiven, P. 67
McPhee copper mine 22, 23
McPherson, Wm. B. 46
McTierman, J. 75
McVichie, J. A. 15, 55
McVittie, J. 13
McVittie, William 46
McVittie tp., gold mg. 30
Madoc.
  Fluorite mg. near 63
  Instruction classes 87-89
Magpie iron m. 13, 22
Maher, W. 86
Mahon, G. W. 54
Mahon, J. C. 46
Maisonville tp., gold mg. 30
Majestic Gold Mines, Ltd. 12, 47
Malahide tp., gravel and sand 82
Maloney, J. 76
Manitou Lake area.
  Gold mg. *See* Grace g.m.
Manley, A. J. 46
Manson, J. T. 68
Maple Sand, Gravel and Brick Co. 86
Marble quarries 73
Marcelis, C. 82
March tp., gravel and sand 82
Marchand, L. J. 29
Marks, J. 64
Marks, J. E. 89
Markus, William 75
Marlborough tp., gravel 81
Marsh, A. W. 67
Marsh, George H. 17
Marshall & Sons, Jas. 76
Martin, Hart 45
Martin, Miss N. F. 59
Martindale, Gilbert 83
Mason, William Thomas 40
Mason-Wilcox iron m. 13, 22
Masters, Adna K. 20, 21
Masterton, W. K. 55
Matachewan l., gold mg. 45
Matheson, J. 14
Matheson, Ont.
  Gold mining near 30
Matheson estate 66
Mathias, Robert 27
Mattagami r., clay 95, 96
Matthews, W. H. 48
Meaford Brick Co. 78
Medonte tp.
  Gravel 85
  Limestone 75
Mein, W. W. 25
Mendels, Joseph H. 11, 59

PAGE

Merkley's Limited 78
Mersea tp., gravel 82
Messecar, C. L. 21
Metallurgical works 15
  Accidents 1-8
  Operating reports 67-69
Metler, Edgar 85
Metz, Gustav 61
Meyer, Peter 80
Meyer, William H. 41
Mica mining 14, 66
Michipicoten area, gold mg. 20
Middlesex co.
  Brick plant 78
  Gravel and sand 84
Middleton, John N. 76
Midlothian tp., gold prospecting 93
Mierzynski, Joseph 17
Mikado Consolidated Mines, Ltd. 13, 17
Millar, Charles 45
Miller, Edwin Lang 44
Miller, G. C.. 31, 42
Miller, Gerard F. 44
Miller, J. A. 74
Miller, W. N. 89
Miller-Adair Mines, Ltd. 13, 45
Miller Independence Mines, Ltd. 13, 28
Miller Lake O'Brien silver m. 14, 57
Mills, Geo. E. 79
Milne, John E. 68
Milton 78
Milton Pressed Brick Co. 78
Minehart, A. G. 11, 61
Miner & Son, John T. 78
Mines.
  Accidents 1-10
  Development reports 11-69
Mining Corporation of Canada 14
  Accident at mine 4
  Report 51, 55
Missinaibi r., clay 95, 96
Mitchell, Arthur 13, 17
Mitchell gravel pit 81
Mitchelson, Sir Archibald 38
Moir, Dr. A. 23
Molybdenite, Monmouth tp. 66
Molybdenite Products Co. 66
Mond, Emile S. 27
Mond, Robert L.. 27
Mond Nickel Co. 14
  Accident at mine 4
  Mining report 27, 28
Monel Metal Products Corp. 25
Monteagle tp.
  Feldspar 60-62
  Molybdenite 66
Montreal-Kirkland Mines, Ltd. 13, 41
Montreal-Ontario Mines, Ltd. 41
Monumental stone 73, 74
Moody, Wm. H. 23
Mooney & St. Denis 75
Moore, George 83
Moore, M. 63
Moore, William M. 39
Moose Mountain, Ltd. 13, 22
Moran, John 63
More, John 15, 24, 69
Morgan, C. E. 92
Morgan, J. W. 89

PAGE
Morgan, M. R. 93
Morrison, G. A. 26
Morrison, J. W. 12, 29, 30
Morrison, Thos. 25
Morrow, James 61
Morrow feldspar mine 11
Morton, John 55
Morton, W. L. 16
Mountain tp., limestone 72
Mount Dennis 86
Mount Eagle Feldspar Co. 11, 60
Mulcahy, Carl W. 20
Mumford, W. J. 14, 27
Munich, A. G. 65
Murdock, James Y. 33
Murphy gold claim 12, 20
Murray nickel mine 14, 24
Murray tp., gravel pits 84
Muscovite. *See* Mica.
Muskoka dist., gneiss quarrying 74
Mutch, D. A. 15
Myer silver m., accident 4
Myhill, William S. 62

N

Napanee.
  Gravel and sand 84
  Town of, working road material .. 74
Neebish islds., quartzite 71
Nelson, J. C. 45
Nelson, Johnson 83
Nelson, K. 48
Nepean tp.
  Gravel pit 81
  Limestone quarries 71, 72
Newell, H. 82
Niagara Alkali Co. 68
Nichol tp., lime kilns 76
Nichols, John 25
Nichols Chemical Co. 4, 18, 64
Nickel and copper.
  Mining accidents 1-8
  Mining reports 22-27
Nickelton smelter 24
Night Hawk l. 39
Night Hawk Peninsula Mines, Ltd. .. 39
Nilsen, A. 4
Nipissing Mines, Ltd. 4, 52-54
Noble, S. W. A. 27
Noonan, William D. 61
Norfolk co., gravel and sand 84
North Bay, classes for prospectors 87, 88, 93
Northcliff Mines, Ltd. 57
Northcrown Porcupine Mines, Ltd. .. 38
Northland, iron mg. near 22
Northpines pyrites mine 4, 18
Northumberland co.
  Gravel and sand pits 84
Northwestern Ontario.
  Mining reports 15
Norton, Alsey 73

O

Oakes, Miss G. 92
Oakes, Harry 41
Oakland tp., gravel pits 80

PAGE
O'Brien, J. A. 54
O'Brien, M. J. 54, 68
  See also Miller Lake O'Brien.
O'Brien and Fowler 60
O'Brien silver mine 54
O'Donnel rapids, Skootamatta r. 63
Oelheim, Charles 16
Offer, W. C. 92
Ogden tp., gold mining 31
Ogilvie, Shirley 50
O'Halloran feldspar quarry 59
Ohl, E. N. 28
Oliver, Dr. 90
Ollman, F. R. 85
Oneida tp., stone quarrying 73
Ontario co., quarrying in 75
Ontario reformatory, Guelph 4, 76
Ontario Dolomite Mfg. Co. 58
Ontario Gypsum Co. 64
Ontario-Kirkland Gold Mines, Ltd. 41, 42
Ontario Porcupine Goldfields Dev. Co. 33
Ontario Rock Co. 75
Ontario Sewer Pipe Co. 79
Ontario Smelters and Refiners, Ltd. . 69
Ophir gold mine 21
Ore Chimney Mg. Co. 63
Orford nickel plant, Bayonne, N.J. . 25
Orillia tps., limestone 75
Orr, Guy H. 85
Orser, Miss D. M. 61
Orser, E. 61
Orser, Sherman 60
Orser, Sidney H. 60
Orser-Kraft Feldspar, Ltd. 60, 61
Osgoode tp., limestone quarry 71
Osler, Britton 24, 25
Ostrowski, James 17
Otonabee tp.
  Brick plant 79
O'Toole, John 59
Ottawa.
  Limestone quarries 71
Ottawa Improvement Commission ... 71
Ottawa Suburban Roads Commission. 71
Ottawa Brick & Tile Co. 79
Owen Sound.
  Brick plant 78
  Gravel and sand 83
  Limestone 72
Owen Sound Brick Co. 78
Oxford co., quarrying in 75
Oxford tp., limestone 72, 76
Oxford Cobalt Silver Mines, Ltd. 54

P

Pacaud tp.
  Gold mining 28
Page, Jacob 85
Painkiller gold mine 30
Paipoonge tp.
  Silver. *See* Federal Mg. Co.
Paisley, gravel pits 80, 81
Palatine iron mine 17
Palmer feldspar mine 61
Palmerston tp., calcite quarrying 59
Paris, T. M. 27

PAGE
Paris Sand & Gravel Co. 80
Park, Hugh 52
Parker, W. R. P. 51
Parkhurst, A. J. 64
Parkhurst, W. A. 64
Parks, H. W. 78
Patno, John D. 64
Patterson, A. 55
Paulson iron mine 17
Paving blocks 73, 74
Peacock, D. C. 18
Peddy, L. 29
Peek, R. L. 48
Peel co., brick plants 78
Pelham tp., gravel and sand 85
  Limestone 76
Pellatt, Henry M. 37
Peloquin, J. B. 41
Pennell, Edward M. 21
Pennsylvania Pulverizing Co. 61
Perth, feldspar quarries near 59
Perth co.
  Gravel and sand pits 84
  Limestone quarries 75
Perth Road, lead mining near 65
Peterborough, gravel quarry 84
Peterborough co.
  Brick plant. *See* Hawkesbury.
  Gravel and sand pits 84
  Limestone quarries 75
Peter McDonald farm. *See* McDonald feldspar quarry.
Peters, ... 67
Pfeiffer, P. C. 52
Phillips, E. 67
Phlogopite. *See* Mica.
Picton, gravel quarrying 84
Pirson, J. 76
Pittsburgh tp.
  Granite gneiss 74
  Limestone 72
Plantagenet tps., limestone 75
Plaster board 64
Plummer tp., copper mining 22
Plunkett, Thomas 51
Poillon, Howard 31
Point Anne 73
Pollock, Alex. 27
Pomeroy, Robt. W. 42
Ponsford, A. E. 82
Poole, F. C. 82
Pooley, Charles A. 28
Pope, A. 4
Pope gold claim 39
Porcupine gold dist.
  Mining reports 31-40
Porcupine Davidson Gold Mines, Ltd. 13, 38
Porcupine Keora Mining Co. 13, 39
Porcupine Peninsular Gold Mines, Ltd. 13, 39
Port Arthur, classes for prospectors 87-89
Port Colborne.
  Blast furnace, refinery 15, 24, 25, 67-69
  Limestone 76

PAGE
Port Elgin.
  Brick plant 78
  Gravel pit 80
Porter, A. R. 20
Portland tp.
  Feldspar quarrying 59
Post, Charles B. 39
Potter, Charles Edward 69
Powers, F. W. 28
Prescott co., quarrying 75
Price, A. E. T. 49
Price & Smith 79
Price talc claim 67
Prince tp. 28
Prince Edward co.
  Gravel and sand pits 84
  Road making 75
Princess silver mine 50, 51
Prior, E. M. 82
Prosecutions (Mining Act) 9
Prospectors, Instruction classes for 87-94
Prosser, Seward 25
Proton 83
Puslinch tp., limestone 76
Pyrites.
  See Northpines.
    Rand Consolidated.
    Sulphide, Ont.

Q

Quarries.
  Accidents 1-9
  Operators 70-77
  Quartz. *See* Dill.
Quartz, Ont. *See* Dill quartz quarry.
Quartz for flux. *See* Flux.
Quartzite.
  Algoma dist., for roads 71
Queen-Lebel Gold Mines, Ltd. 42
Queenston Quarry Co. 74
Quinn, Clement A. 17

R

Racuba, D. 4
Rainville, J. H. 29
Raleigh tp., sand pit 83
Rama tp., gneiss quarry 75
Ramsay tp., crystalline limestone 73
Rand Consolidated Mines, Ltd. 14, 28
Rawlins, James W. 26
Ray, Col. S. W. 89
Raymond, A. 29
Rea, E. A. 54
Rea, T. H. 33
Reamsbottom, W. H. 20
Redden, Henry 84
Reid, A. J. 67
Reid, Fraser D. 48
Reider, T. H. 41
Reliance silver mine 54
Renfrew.
  Limestone quarry 75
Renfrew co.
  Brick plant. *See* Arnprior.
  Gravel pits 84
Renwick, John 64
Rhodes, E. N. 24

PAGE

Ribble Mines, Ltd. 46
Richards, Robert R. 20, 21
Richards, William J. 16
Richardson, U. 30
Richardson feldspar mine 59
Rideau canal.
  Limestone quarrying 71
Ridgeville Concrete Works 85
Riley, Charles W. 15
Road material 70-86
Robertson, Charles M. 66
Robertson, J. F. 27
Robertsville, calcite near 59
Robinson, John 61
Robinson, L. V. 64
Rock lakes, Storrington tp. 62
Rockcliffe, sand and gravel 81
Rock Products Co. 60
Rockwood, limestone 76
Rodda F. 90
Rogers, George R. 46
Rogers, R. P. 48
Rogers, Richard B. 23
Rognon, E. R. 15
Rolfe, W. J. 26
Rollins, D. W. 78
Romney, sand pit 83
Rosa, Savario D. 45
Roscoe, H. L. 24
Rose, E. H. 51
Rose, R. R. 66
Rose tp., copper mining 22
Ross, Walter 16
Rudd, S. R. 82
Russell, J. W. 54
Russell, W. H. 16
Russell Co., John E. 83
Russell.
  Brick plant 79
Russell co., quarrying 75
Russell tp., limestone 75

S

St. Anthony gold m. 17
St. Anthony l., gold mg. 31
St. Charles, Dr. W. P. 41
St. George, M. J. 17
St. Jean Bros. 82
St. Mary r. 28
St. Mary's Cement Co. 75
St. Vincent tp., brick plant 78
Saltfleet tp.
  Limestone quarries 77
  Sand and gravel 86
Sand and Gravel.
  Accidents in working 1-9
  Missinaibi river 95
  Operators and pits 80-86
Sand and Supplies, Ltd. 85
Sanderson silver claims 58
Sandstone quarries 71
Sarjeant Co. 85
Sass, William T. 42
Sault Ste. Marie.
  Classes for prospectors 87-89
Scarboro tp., sand and gravel 86
Schreiber, gold mg. near 16

PAGE

Scott, F. S. 85
Scott, J. G. 85
Scott, J. Ralph 59
Scott & Nicholson 84
Seitz, Leo B. 61
Selick, A. 4
Selkirk, A. V. J. 20
Sellwood, R. M. 18
Sellwood, Ont. 22
Seneca tp.
  Gypsum. *See* Caledonia.
Serpell, William J. 27
Sesekinika.
  Gold mining near 30, 40
Sewer pipe plants 79
Seymour, William 21
Shaff, Henry 30
Shaff, John 30
Shakespeare tp., copper mg. 23
Sharp, Capt. A. L. 27
Shaw, John M. 28
Shaw, J. R. 54
Shaw tp., gold mg. 39
Shelley, Geo. 82
Shephard, Barry 93
Sheppard, W. J. 37
Sherbrooke tps., mica and feldspar 61, 66
Sherkston, gravel and sand 76
Shields, W. J. 45
Shirk, G. M. 85
Shoefelt, Jacob 12
Shoefelt silver claim 12, 28
Shoemaker, A. 85
Shovel, William 27
Silica, Ohio 61
Silver mines 14, 15
  Accidents 1-8
  Mining reports 18, 47-55
Silver Cliff silver m. 15, 47, 55
Silver Islet silver m. 15, 18, 19
Silver Queen silver m. 15, 55
Simcoe co.
  Gravel pits 85
  Stone quarrying 75
Simms, Frank 27
Simpson H. K. 44
Simpson, W. E. 28
Sixt, W. M. 12, 40
Skead tp.
  Gold mining. *See* Skead Gold
    Mines, Ltd.
Skead Gold Mines, Ltd. 31
Skidoo l. 30
Skootamatta river 63
Slaght, Arthur G. 41
Slee, Frederick 68
Sligh, Charles R. 21
Sloane gravel pit 83
Slush, T. H. 84
Smallwood, F. 21
Smelters.
  See Blast furnaces.
    British American Nickel Corp.
    Copper Cliff.
    Port Colborne.
Smith, Albert 4
Smith, E. A. Cappelen 24

PAGE
Smith, H. B. 4
Smith, H. Coleman 20
Smith, Richard 66
Smith, Robert M. 58
Smith Bros. 78, 80
Smith tp., gravel pits 84
Smiths Falls, limestone quarry 73
Smith-Labine gold claims 40
Smyth, C. 86
Smythe, W. R. 45
Somerville tp., limestone 75
Soule, W. H. 27
South Cedar Springs 83
Southern Ontario.
  Mining reports 58-86
South Lorrain tp.
  Silver mg. 55-57
South Porcupine.
  Classes for prospectors 87, 88, 92
Southworth, Thomas 68
Spada, L. 4
Sparling, Fred. W. 20
Spauling, Willis M. 33
Spawning l. 57
Speer, C. H. 21
Spratt, J. A. Harvey 82
Sprecher, G. A. 25
Sproat, George R. 45
Stamford tp.
  Gravel and sand pits 85
  Limestone for flux 76
Standard Brick Co. 79
Standard Chemical Co. 75
Standard White Lime Co. 4, 75
Stanley, John 82
Stanley, R. C. 24, 25
Stansbury, Edwin 48
Starke, Col. Robt. 38
Steel Company of Canada 15, 69
Steele, Edwin G. 79
Stenbol, Carl 21
Stern, Morton F. 31
Stevenson, P. C. 24
Stevenson, William 46
Stewart, H. J. 30
Stoddard, John 82
Stokloser, Karl 89
Stone. *See* Building stone; Granite; Limestone; Trap; Sandstone.
Stonehouse l. 62
Stormont co., quarrying 75
Storrington tp.
  Feldspar mining 62
  Gravel pit 83
Storrington Feldspar Co. 62
Stothart, Jas. 84
Street & O'Brien 74
Streetsville Brick Co. 78
Strong, H. F. 55
Sturgeon falls, Mattagami r. 37
Sudbury.
  Classes for prospectors 87-90
Sudbury dist.
  Gold mg. 29
  Nickel. *See* Nickel.
Sullivan, Joseph T. 21
Sullivan, Roy 57

PAGE
Sun Brick Co. 79
Sutherland, H. H. 38
Sutherland, T. F. 1, 11
Swansea, brick plant 79
Swartz, John 40
Swastika, classes for prospectors 87, 88, 91
Sweeney, W. R. 47
Sydenham, mica mg. near 66
Syenite.
  Leeds tp., for monuments 73

T

Tack, Henry 84
Tarbutt tp., silver prospecting 28
Taylor, Alexander 21
Taylor, C. H. 30
Taylor, Charles O. 57
Taylor, Frank 26
Taylor, L. 86
Taylor, T. 89
Tebbutt, John T. 41
Teck-Hughes Gold Mines, Ltd.
  Mining report 42, 43
  Prosecution under mg. act. 9
Teeples, Alexander 62
Teeples feldspar claim 12, 62
Teeswater 71
Telfer, R. A. 64
Terracotta.
  Gloucester tp. 78
Terrill, Albert 20
Thames Quarry Co. 75
Thaw, William 39
Theaker, W. 86
Thesaurus Gold Mines, Ltd. 13, 45
Thomas, Hon. I. B. F. 38
Thomas, Matthew 39
Thomas, W. R. 13, 44
Thompson, C. 14
Thompson, C. H. 66
Thompson, C. N. 65
Thompson, E. J. 14, 57
Thompson, J. F. 42
Thompson, Robt. H. 11, 61
Thompson, S. C. 44
Thompson, Stephen G. 23
Thompson-Krist gold m. 38
Thorold, smelter 15,68
Thunder Bay dist.
  Silver mining 18, 19
Thurlow tp.
  Brick plant 78
  Limestone quarry 73
Tichborne.
  Feldspar mg. near 59, 62
  Mica mg. near 66
Tile plants 78, 79
Timmins, Jules, R. 34
Timmins, L. H. 34
Timmins, Noah A. 34
Timmins, Ont.
  Classes for prospectors 87, 88, 92
  Gold. *See* Hollinger Consolidated.
Timmins feldspar quarry.
Todd, W. H. 15, 28
Tolman, C. M. 22

PAGE

Tomlinson, B. C. 24
Tompkins, G. 4
Torbolton tp., limestone 75
Toronto tp., brick plant 78
Toronto Brick Co. 76, 79
Tough, George 40
Tough, R. B. 12
Tough, Thos. B. 57
Tough-Oakes Gold Mines, Ltd. 13, 43, 44
Tower, William O. 25
Townsend tp., gravel and sand 84
Trafalgar tp., brick plant 78
Trafford, C. E. 51
Train, Mr. 91
Treleaven, R. A. 30
Trethewey Silver-Cobalt Mining Co. 15, 58
Triplex Gold Mines, Ltd. 13, 39
Troop, Stewart 15, 58
Tudor tp., lead mining 65
Tuke, W. H. 91
Turczynowicz, Roman 17
Turk, E. 56
Turner, Scott 51
Tycoon gold mine 17
Tyendinaga tp., limestone 73
Tyrrell, J. B. 41

U

Union Gold Mines Trust, Ltd. 40
Union Mining Corp. 13, 40
Universal Silicates, Ltd. 60
University silver mine 14, 50, 51
Upper Rock l. 62

V

Vanderlip, Joseph H. 23
Vander Voort, M. P. 20
Van Hise tp., silver mg. 57
Vanluven, Albert 12, 62
Vaughan tp., sand and gravel 86
Vernon 71
Verona 59
Verona Mining Co. 62
Victoria co.
  Limestone quarrying 75
Victoria nickel mine 14, 27
Victoria silver mine 4
Victory Silver Mines, Ltd. 15, 55
Violet silver mine 14, 50, 51
Vogt, D. 24

W

Wachman gold m. 17
Wagar, Richard 11, 59
Waide, J. C. 78
Wainfleet tp., limestone 76
Waite, J. C. 13, 39
Wallbridge, C. W. 89
Wallbridge Bros. 12, 63
Walker, Arthur 4
Walker, Sir Edmund 27
Walker, George 30
Walker Bros. 76
Wallace gravel pit 81
Walpole tp., stone quarrying 73

PAGE

Walton, C. G. 12, 62
Wangler, William 82
Wanless, G. A. 42
Warren, F. A. 66
Warwick Brick Works, Ltd. 78
Wasapika lake. *See* White Rock Gold Mg. Co.
Wasapika Consolidated Mines, Ltd. 13, 46
Washago limestone quarry 4
Washburn, J. L. 18
Washington, J. L. 18
Watabeag r., waterpower 30
Waterdown 77
Waterloo co.
  Brick plant. *See* Kitchener.
  Gravel and sand 85
  Stone quarrying 76
Waterloo tp. 85
Waterpower, Skootamatta r. 63
Watson, Alex. 11, 58
Watson, A. H. 89
Watson, C. G. 93
Watson, J. G. 51
Watson, J. P. 51
Watson, R. B. 52
Watson feldspar claim 11, 60
Watts, N. 89
Wawa l. 21
Webbwood, copper mg. near 23
Webster, A. R. 1, 11
Weir's gravel pit 84
Weldon, Robert P. 21, 22
Welland, smelter 69
Welland co.
  Gravel and sand 85
  Limestone quarrying 76
Wellington co.
  Gravel and sand 85
  Limestone quarrying 75
Wells, R. G. 69
Wende, Albert 13, 41, 44
Wentworth co.
  Brick plants 79
  Gravel and sand 85, 86
  Limestone 76, 77
Wentworth Quarry Co. 77
Westlake, E. A. 49
West Lake Brick & Products Co. 84
West River station 47
West Shiningtree Lake dist.
  Gold mining 45, 46
West Toronto, sand and gravel 86
Wettlaufer, C. E. 40, 41
Whitby, O. W. 64
White, Homer 84
White, J. T. 17
Whitefish lake, Brougham tp. 64
White Rock Mining Co. 13, 46
Whitesides tp., gold mg. 40
Whitney tp.
  Gold. *See* Porcupine Keora.
Wiarton, limestone 71
Wigren, Eugene A. 20
Wigwam, Ont. 58
Wilberforce molybdenite m. 14
Wiley, Mr. 14
Wilkes, John 59

PAGE

Williamsburg tp.
  Gravel and sand pits 81, 82
Williamson, J. C. 56
Wilson, A. H. 54
Wilson, E. R. 23
Wilson, Joseph W. 21
Wilson, Dr. S. C. 60
Wilson & Sons, Samuel 78, 80
Winchester tp.
  Gravel and sand 81
Windmill Point 72
Windsor Brick & Tile Co. 78
Windsor Sand & Gravel Co. 82
Wink, A. S. 90
Winning limestone quarry 75
Wolfe, W. E. 89
Wollaston tp., limestone quarry 73
Wood, E. B. 13, 42
Wood, E. E. 90
Wood, E. R. 24
Wood, W. G. A. 92
Woodcock feldspar mine 11, 61
Woodland, H. 4
Woodland, W. 4
Woods, William J. 61
Wood's vein, Keeley s.m. 56
Workman, J. K. 26
Workman's Compensation Act 1, 2
Worth, S. Harry 63
Worthington nickel mine 14, 28
Wright, John C. 78

PAGE

Wright, S. B. 15, 68
Wright, Wm. H. 41
Wright & Co. 80
Wright-Hargreaves Mines, Ltd. 13
  Mining report 44, 45
Wydra, Frank 17
Wylie, B. M. 89

Y

Yarmouth tp.
  Gravel and sand 82
Yates, Harry 68
Yeo I., sand brick 84
Yonge tp., gravel and sand 84
York co.
  Brick plants 79
  Gravel and sand 86
York tp. 86
York Sand and Gravel Co. 86
York Sandstone Brick Co. 86
Young, A. J. 47
Young, Horace G. 21
Young, W. 74

Z

Zander, Hugo 21
Zettler, Andrew 81
Zettler, William 81
Zolkowski, A. 17

University of Toronto
Library

DO NOT
REMOVE
THE
CARD
FROM
THIS
POCKET

Acme Library Card Pocket
Under Pat. "Ref. Index File"
Made by LIBRARY BUREAU

TN
27
06A33
1922
pt.3-10
cop.2
Engineering

Ontario. Dept. of Mines
Annual report

PLEASE DO NOT REMOVE
CARDS OR SLIPS FROM THIS POCKET

UNIVERSITY OF TORONTO LIBRARY

ENGIN STORAGE

Gov Doc
Ont
M
TN
27
O6A33

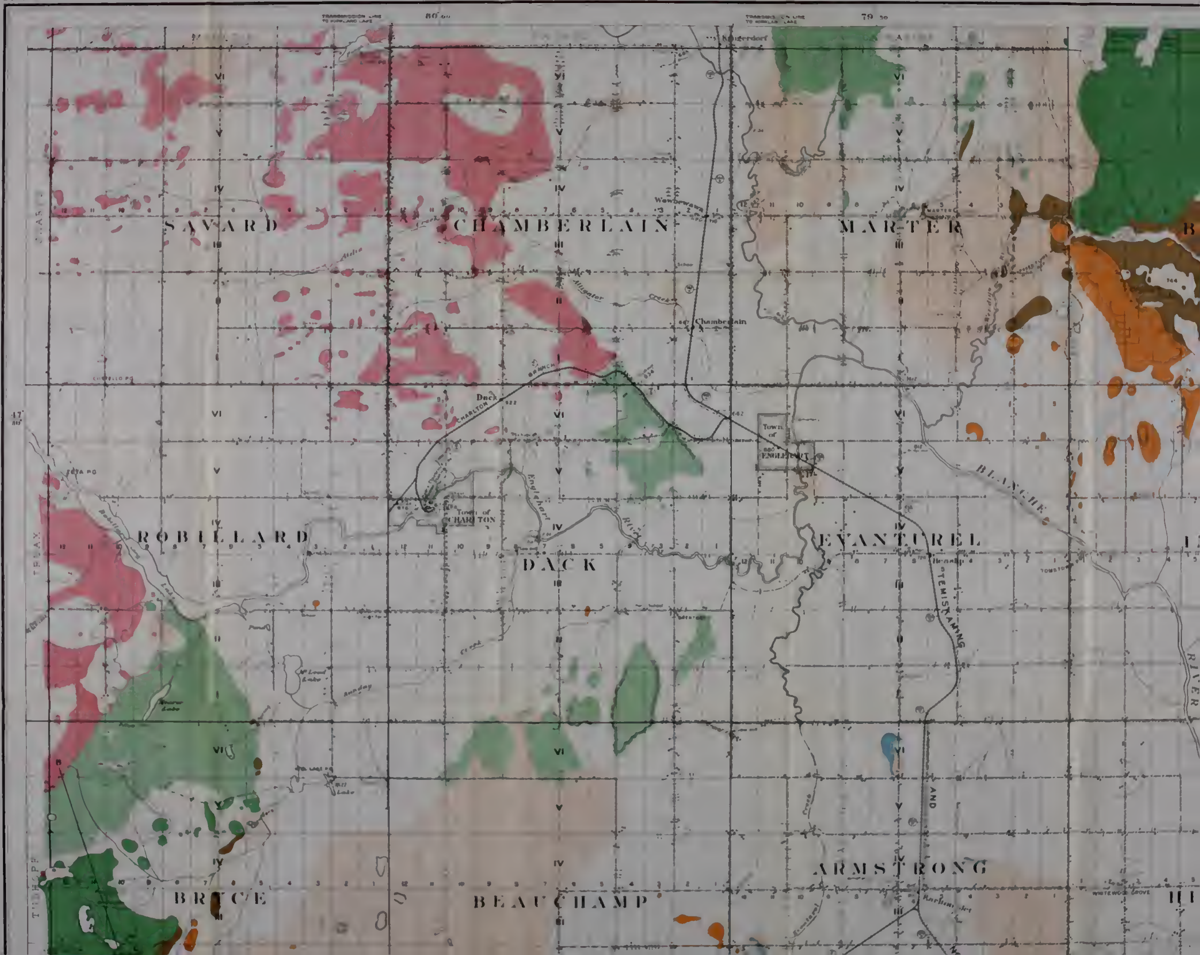
PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon H Mills Minister of Mines

Willet G Miller Provincial Geologist

Map No 31b

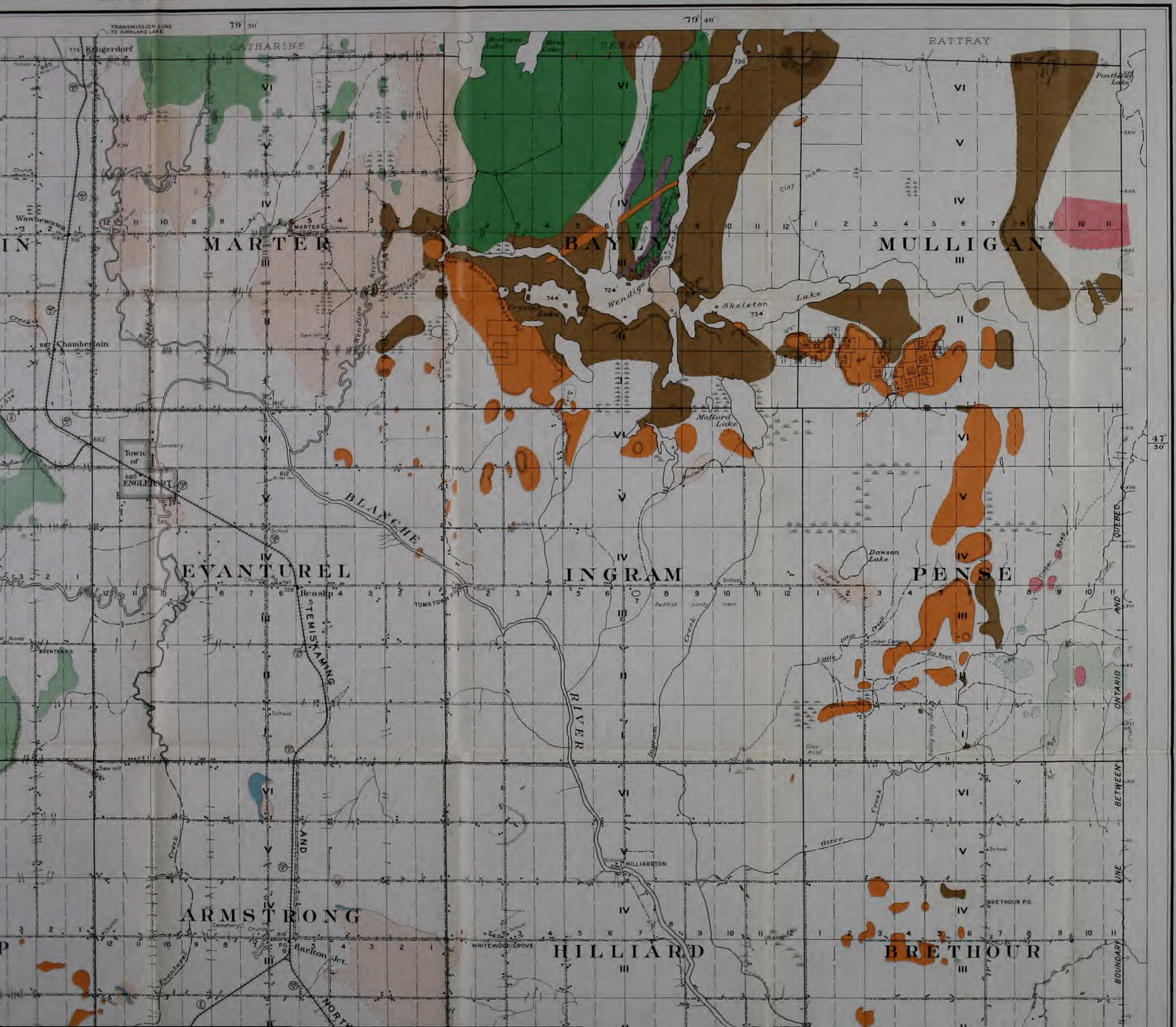
BLANCHE RIVER AREA



PROVINCE OF ONTARIO

DEPARTMENT OF MINES

Hon. H. Mills, *Minister of Mines* Willet G. Miller, *Provincial Geologist*



LEGEND

PLEISTOCENE

Glacial and Recent

▭ *Peat bog.*

▭ *Sand, gravel, sandy loam, boulders.*

▭ *Stratified clay, boulder clay, clay loam, sandy clay.*

PALEOZOIC

Silurian

🟦 *Lockport dolomite and sandstone.*

▨ *Cataract limestone and impure shales.*

Ordovician

🟦 *Trenton Limestone.*

Unconformity

PRE-CAMBRIAN

Keweenawan

🟧 *Diabase dikes and sills, granophyre.*

Intrusive contact

Animikie (Cobalt series)

▭ *Quartzite.*

🟫 *Conglomerate, arkose, greywacke and slate.*

Unconformity

🟥 *Quartz-porphyry, aplite, felsite and lamprophyre dikes.*

🟥 *Hornblende biotite granite and gneiss.*

Intrusive contact

Pre-Algoman

🟪 *Diabase*

Intrusive contact

Keewatin

🟩 *Rhyolite, andesite and dacite.*

🟩 *Amygdaloidal and ellipsoidal basalt, agglomerate, diabase, hornblende and chlorite schist.*

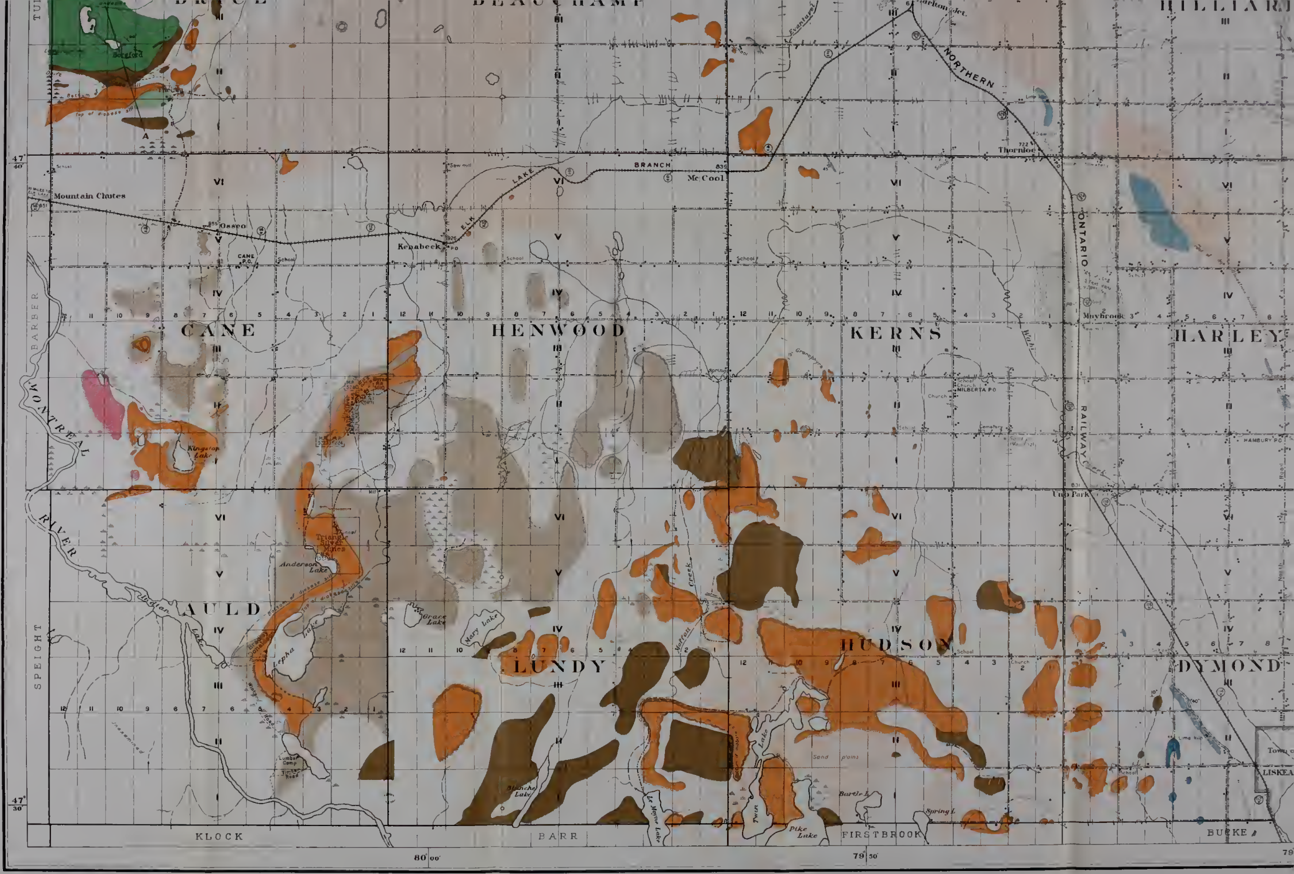
▭ *Mica schist.*

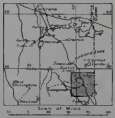
Symbols

▭ *Hill.*

▭ *Swamp.*

▭ *Creek.*





Map Nº 31 b.

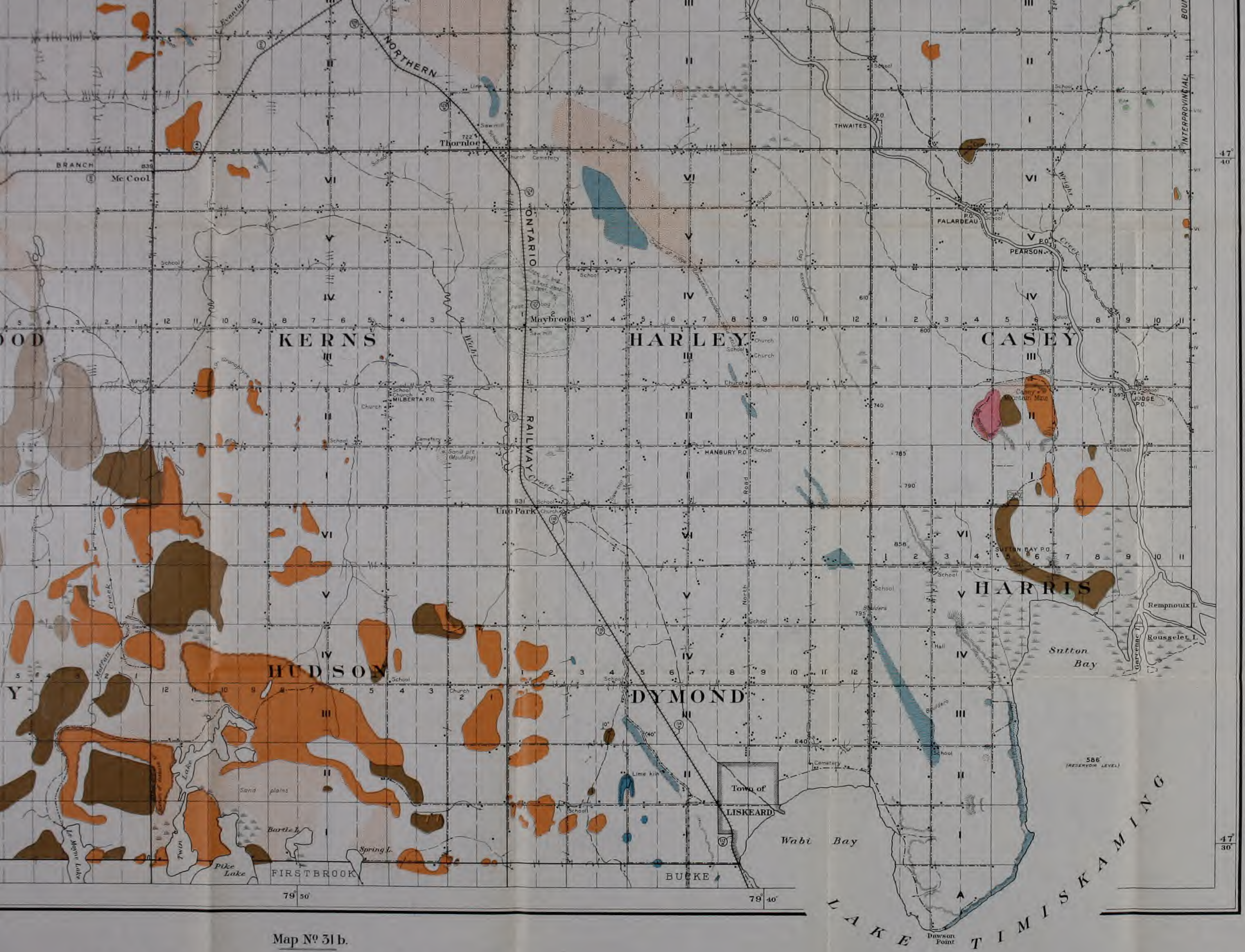
BLANCHE RIVER AREA

DISTRICT of TIMISKAMING, ONTARIO

To accompany Ontario Department of Mines Report, Volume XXXI, Part 3, 1922, by A.G. Burrows *and* P.E. Hopkins

Scale: $\frac{1}{63,360}$ or 1 Mile = 1 Inch

Chains 80 40 0 1 2 3 4 Miles



- Hill.
- Swamp.
- Creek.
- Trail or portage.
- Road under construction.
- Road completed for vehicles.
- Bridge over stream.
- Building.
- Electric transmission line.
- Railway, with station and mileage north of North Bay Junction.
- 631 Altitude in feet above sea level.
- Glacial striae.
- 60° Strike and dip.
- Strike and vertical dip.
- Geological boundary, defined.
- Geological boundary, assumed.
- Shaft or prospect pit.
- Vein.

Explanatory Note

The line A—B in Bryce township refers to a vertical section illustrated in the report accompanying this map.

Map Nº 31 b.

BLANCHE RIVER AREA

DISTRICT OF TIMISKAMING, ONTARIO

To accompany Ontario Department of Mines Report, Volume XXXI, Part 3, 1922, by A.G. Burrows *and* P.E. Hopkins.

Scale: $\frac{1}{63,360}$ or 1 Mile = 1 Inch

Chains 80 40 0 1 2 3 4 Miles

Sources of Information

Township and mining claim plans: Surveys Branch, Department of Lands and Forests, Ontario.

Maps published by the Ontario Department of Mines, namely: Wendigo Lake, 1907; Cobalt-Nickel-Arsenic-Silver Area, 1910; Cane and Auld, 1921.

Map in advance of publication by G. S. Hume, *Geological Survey of Canada.*

Altitudes and outline of Maybrook peat bog based on Temiskaming and Northern Ontario Railway Surveys.

Geology by A. G. Burrows *and* P. E. Hopkins.

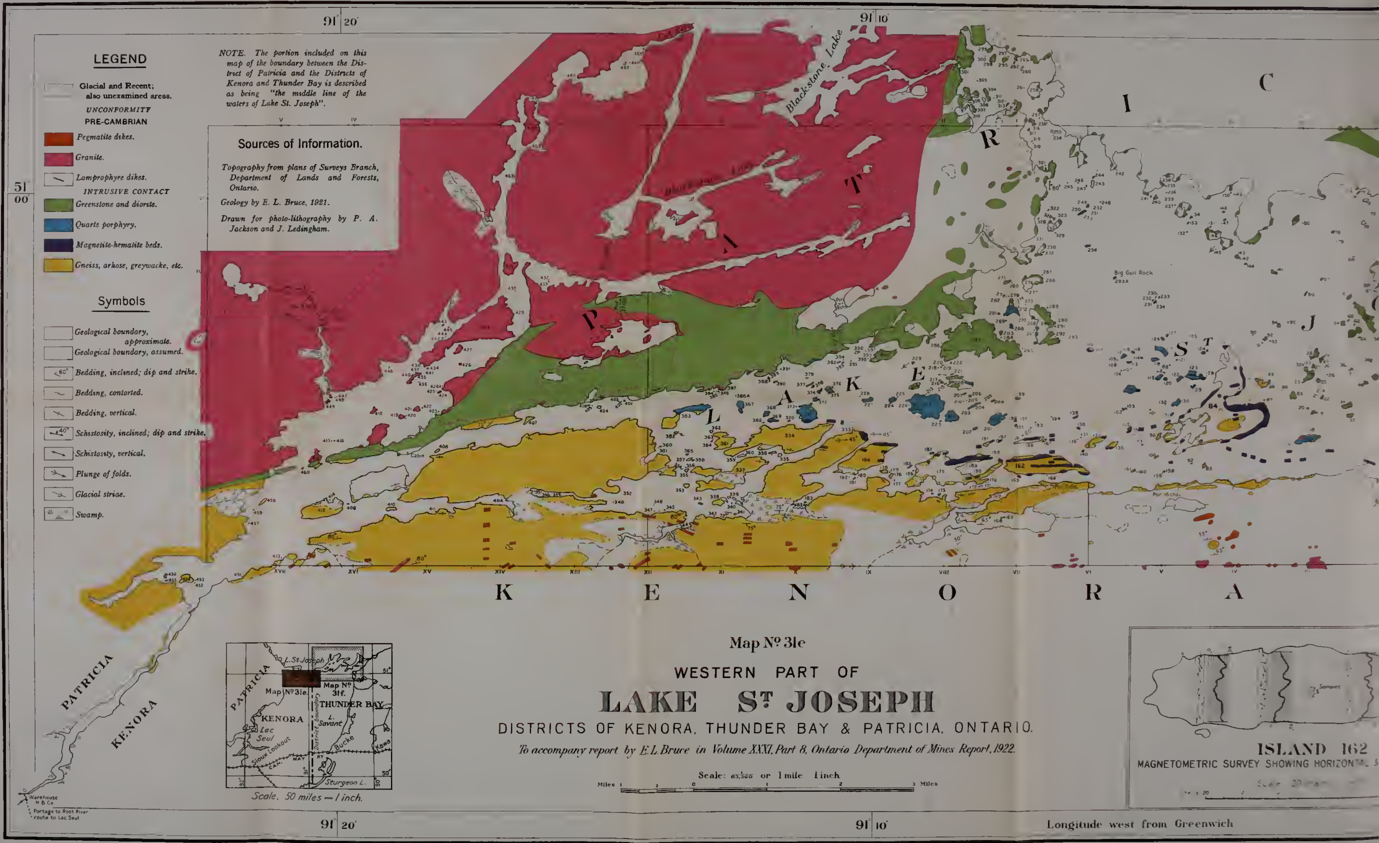
Drawn for photolithography by J. Ledingham.

Gov Doc.
Ont
M
TN
27
O6 33

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, *Minister of Mines* Willet G. Miller, *Provincial Geologist*

Map No 31e
LAKE St JOSEPH



LEGEND

Glacial and Recent; also unexamined areas.

UNCONFORMITY

PRE-CAMBRIAN

- 🟥 *Pegmatite dikes.*
- 🟥 *Granite.*
- *Lamprophyre dikes.*

INTRUSIVE CONTACT

- 🟩 *Greenstone and diorite.*
- 🟦 *Quartz porphyry.*
- ■ *Magnetite-hematite beds.*
- 🟨 *Gneiss, arkose, greywacke, etc.*

Symbols

- *Geological boundary, approximate.*
- *Geological boundary, assumed.*
- *Bedding, inclined; dip and strike.*
- *Bedding, contorted.*
- *Bedding, vertical.*
- *Schistosity, inclined; dip and strike.*
- *Schistosity, vertical.*
- *Plunge of folds.*
- *Glacial striae.*
- *Swamp.*

NOTE. The portion included on this map of the boundary between the District of Patricia and the Districts of Kenora and Thunder Bay is described as being "the middle line of the waters of Lake St. Joseph".

Sources of Information.

Topography from plans of Surveys Branch, Department of Lands and Forests, Ontario.

Geology by E. L. Bruce, 1921.

Drawn for photo-lithography by P. A. Jackson and J. Ledingham.

Map No 31e

WESTERN PART OF

LAKE St JOSEPH

DISTRICTS OF KENORA, THUNDER BAY & PATRICIA, ONTARIO.

To accompany report by E. L. Bruce in Volume XXXI, Part 8, Ontario Department of Mines Report, 1922.

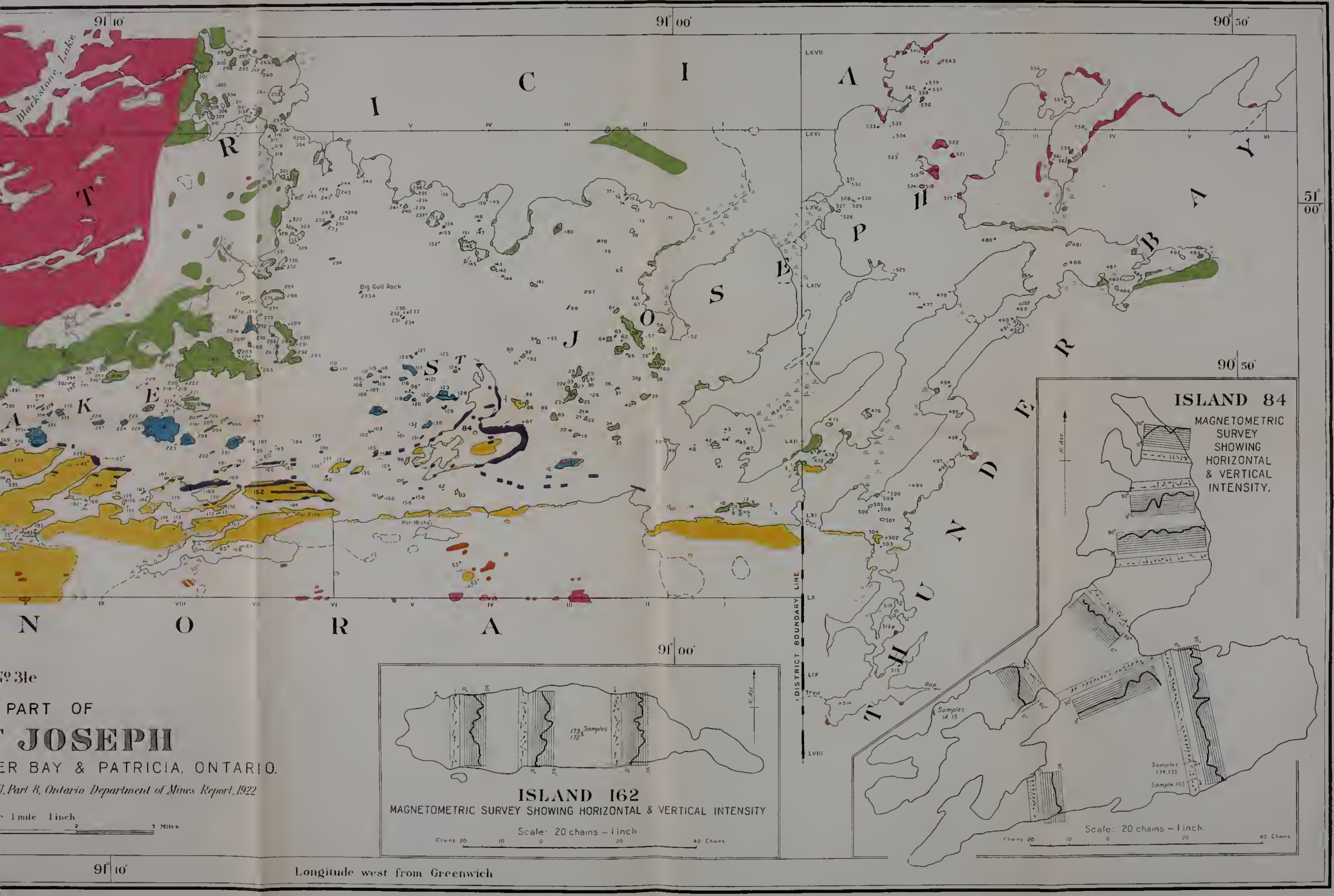
Scale: 1/63,360 or 1 mile = 1 inch.

ISLAND 162

MAGNETOMETRIC SURVEY SHOWING HORIZONT

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, *Minister of Mines* Willet G. Miller, *Provincial Geologist*



Nº 31e

PART OF

JOSEPH

ER BAY & PATRICIA, ONTARIO.

l, Part 8, Ontario Department of Mines Report, 1922

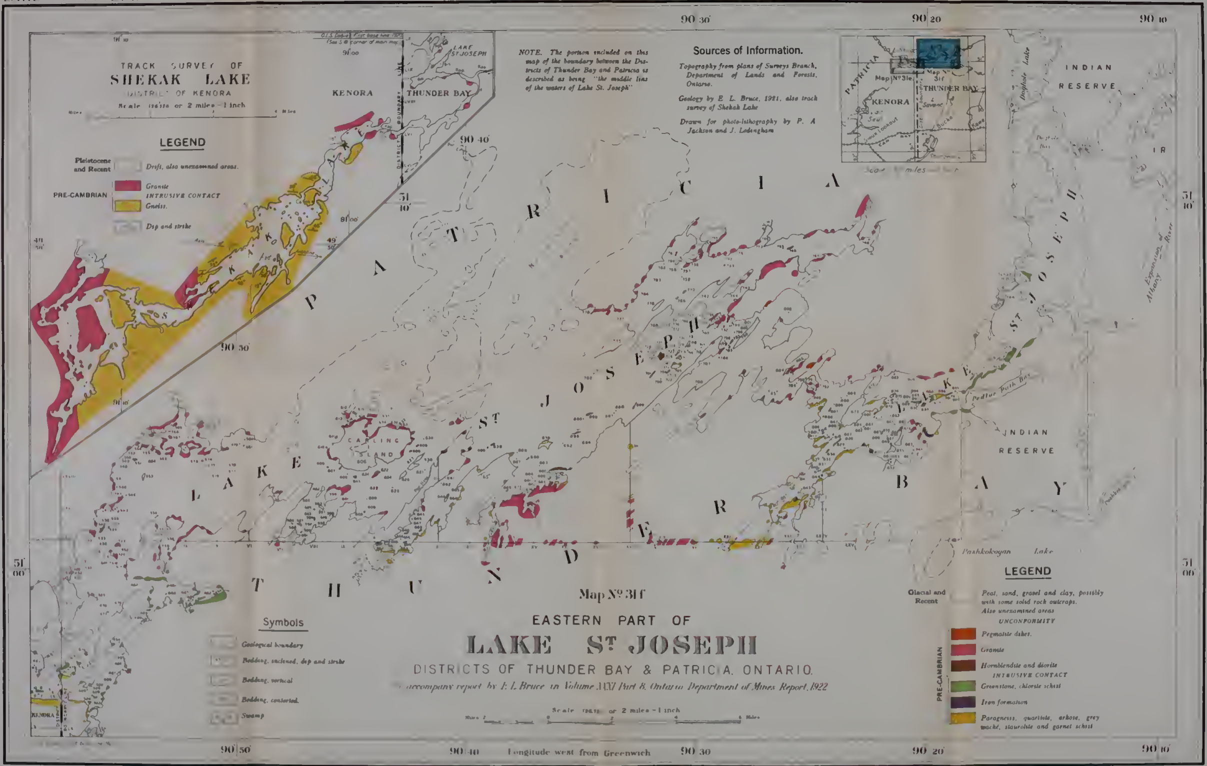
1 mile 1 inch

Gov.Doc
Ont
M
TN
27
06433

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, *Minister of Mines*   Willet G Miller, *Provincial Geologist*

Map Nº 31f
LAKE Sᵀ JOSEPH



NOTE. The portion included on this map of the boundary between the Districts of Thunder Bay and Patricia is described as being "the middle line of the waters of Lake St. Joseph"

Sources of Information.

Topography from plans of Surveys Branch, Department of Lands and Forests, Ontario.

Geology by E. L. Bruce, 1921, also track survey of Shekak Lake

Drawn for photo-lithography by P. A. Jackson and J. Ledingham

Map Nº 31f

EASTERN PART OF

LAKE Sᵀ JOSEPH

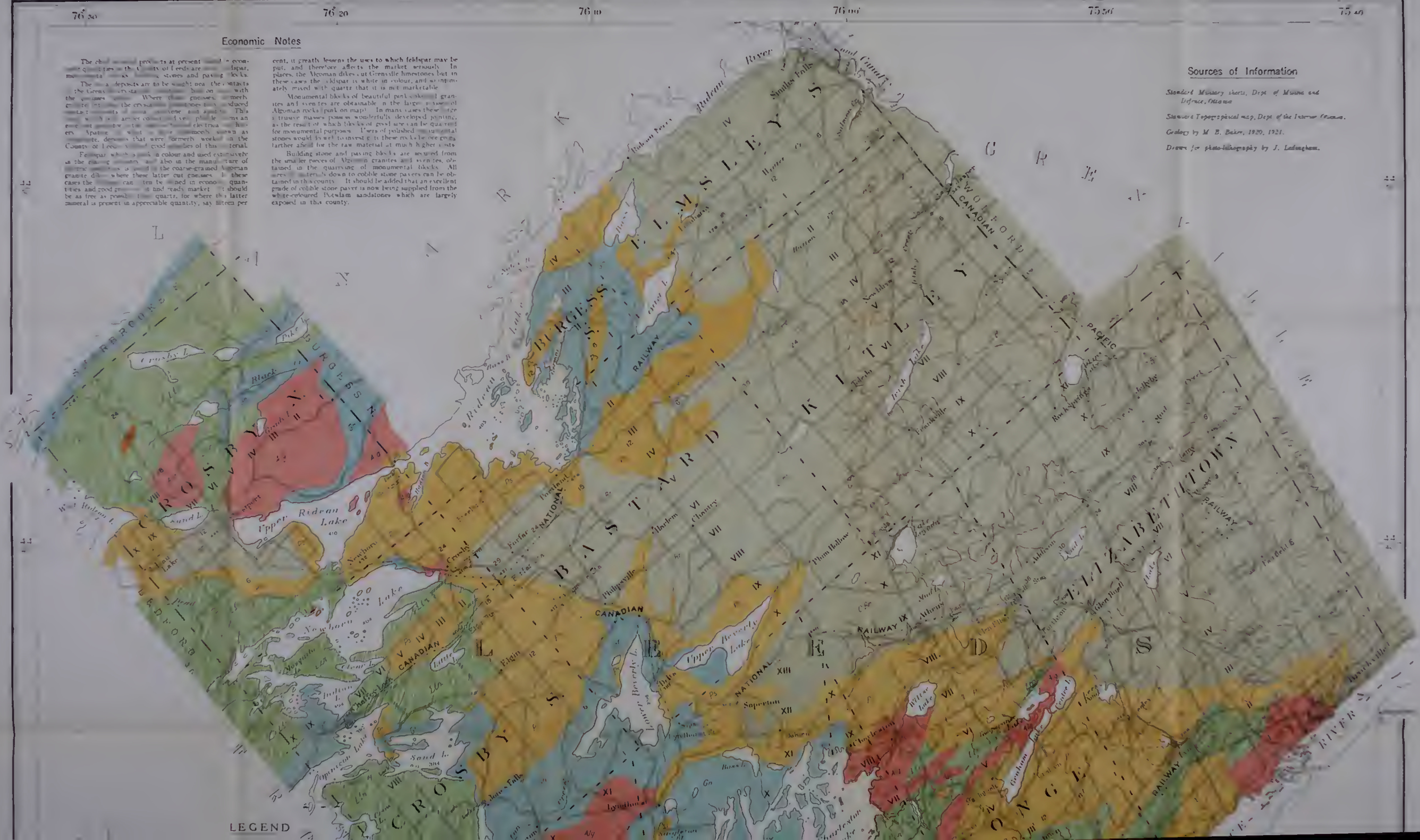
DISTRICTS OF THUNDER BAY & PATRICIA, ONTARIO.

To accompany report by E. L. Bruce in Volume XXXI Part 8, Ontario Department of Mines Report, 1922

Gov Doc
Can
M
TN
27
O6A33

Map No. 31c

COUNTY of LEEDS



Economic Notes

The chief mineral products at present [illegible] in economic quantities in the County of Leeds are mica, feldspar, monumental stones, building stones and paving blocks.

The mica deposits are to be sought near the contacts of the Grenville crystalline limestones, but on [illegible] with the gneisses [illegible]. Where these gneisses, formerly granite, intrude the crystalline limestones they produced [illegible] amounts of mica, [illegible] and apatite. This mica, which is of amber colour and very pliable, forms an excellent [illegible] in the [illegible] electrical [illegible]. Apatite, or what is more commonly known as phosphate, deposits that were formerly worked in the County of Leeds [illegible] good [illegible] of this material.

Feldspar, which is pink in colour and used extensively in the [illegible] industry and also in the manufacture of [illegible], is found in the coarse-grained Algoman granite dikes where these latter cut gneisses. In these cases the feldspar can often be mined in economic quantities and good [illegible] find ready market. It should be as free as possible from quartz, for where this latter mineral is present in appreciable quantity, say fifteen per cent, it greatly lessens the uses to which feldspar may be put, and therefore affects the market seriously. In places, the Algoman dikes cut Grenville limestones but in these cases the feldspar is white in colour, and so intimately mixed with quartz that it is not marketable.

Monumental blocks of beautiful pink-coloured granites and syenites are obtainable in the larger masses of Algoman rocks (pink on map). In many cases these large intrusive masses possess wonderfully developed jointing, as the result of which blocks of good size can be quarried for monumental purposes. Users of polished monumental stones would do well to investigate these rocks before going farther afield for the raw material at much higher costs.

Building stone and paving blocks are secured from the smaller pieces of Algoman granites and syenites, obtained in the quarrying of monumental blocks. All sizes of materials down to cobble stone pavers can be obtained in this county. It should be added that an excellent grade of cobble stone paver is now being supplied from the white-coloured Potsdam sandstones which are largely exposed in this county.

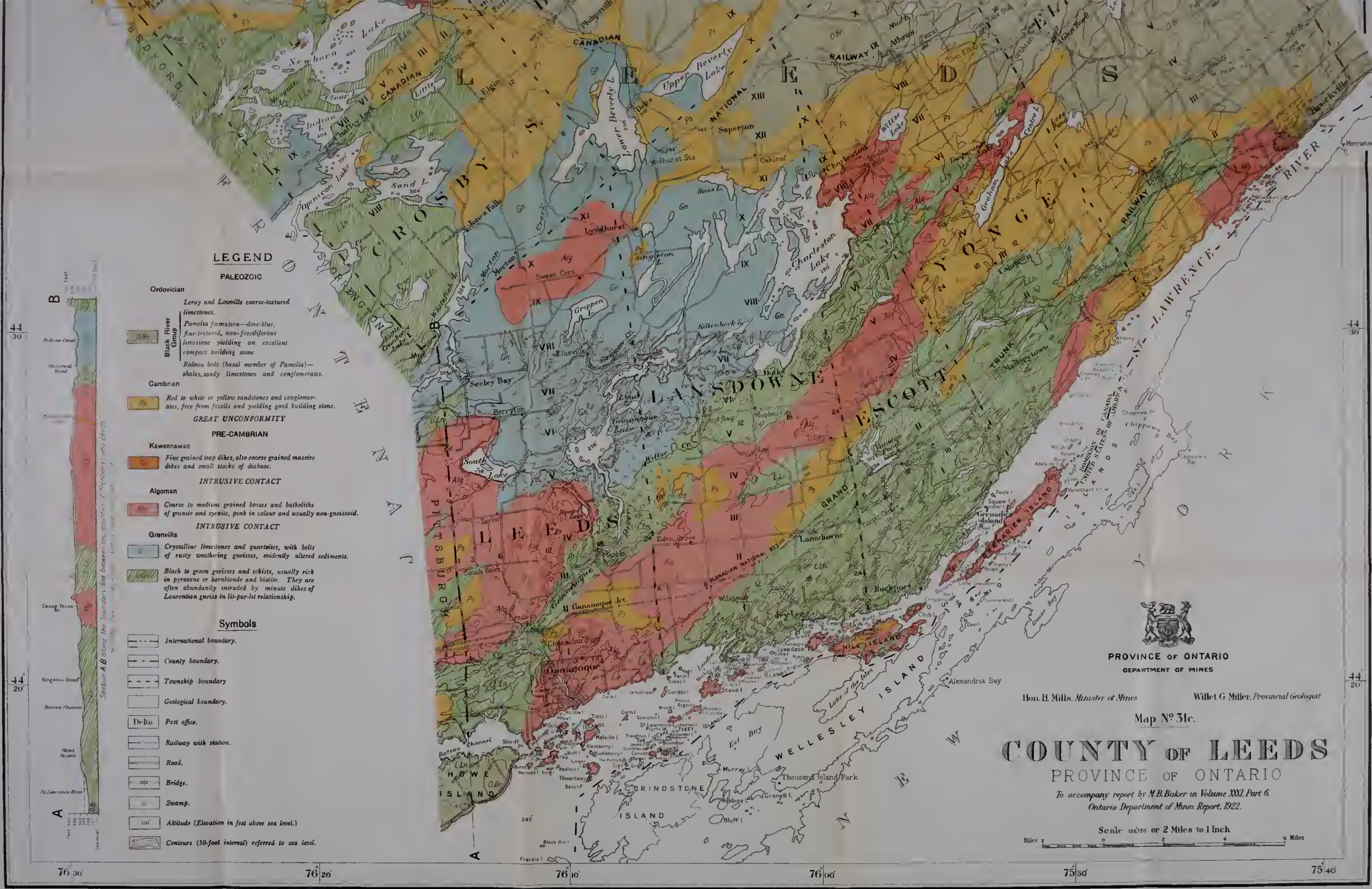
Sources of Information

Standard Military sheets, Dept. of Militia and Defence, Ottawa.

Standard Topographical map, Dept. of the Interior Ottawa.

Geology by M. B. Baker, 1920, 1921.

Drawn for photo-lithography by J. Ledingham.



LEGEND

PALEOZOIC

Ordovician

O.Br. Black River Group:
- Leray and Lowville coarse-textured limestones.
- Pamelia formation—dove-blue, fine-textured, non-fossiliferous limestone yielding an excellent compact building stone
- Rideau beds (basal member of Pamelia)—shales, sandy limestones and conglomerates.

Cambrian

Ps. *Red to white or yellow sandstones and conglomerates, free from fossils and yielding good building stone.*

GREAT UNCONFORMITY

PRE-CAMBRIAN

Keweenawan

🟧 *Fine grained trap dikes, also coarse grained massive dikes and small stocks of diabase.*

INTRUSIVE CONTACT

Algoman

Alg. *Coarse to medium grained bosses and batholiths of granite and syenite, pink in colour and usually non-gneissoid.*

INTRUSIVE CONTACT

Grenville

G *Crystalline limestones and quartzites, with belts of rusty weathering gneisses, evidently altered sediments.*

Lln *Black to green gneisses and schists, usually rich in pyroxene or hornblende and biotite. They are often abundantly intruded by minute dikes of Laurentian gneiss in lit-par-lit relationship.*

Symbols

- *International boundary.*
- *County boundary.*
- *Township boundary.*
- *Geological boundary.*
- Delta *Post office.*
- *Railway with station.*
- *Road.*
- *Bridge.*
- *Swamp.*
- 310′ *Altitude (Elevation in feet above sea level.)*
- *Contours (50-foot interval) referred to sea level.*

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, *Minister of Mines* — Willet G. Miller, *Provincial Geologist*

Map Nº 31c.

COUNTY OF LEEDS
PROVINCE OF ONTARIO

To accompany report by M. B. Baker in Volume XXXI, Part 6.
Ontario Department of Mines Report, 1922.

Scale 1/126,720 or 2 Miles to 1 Inch

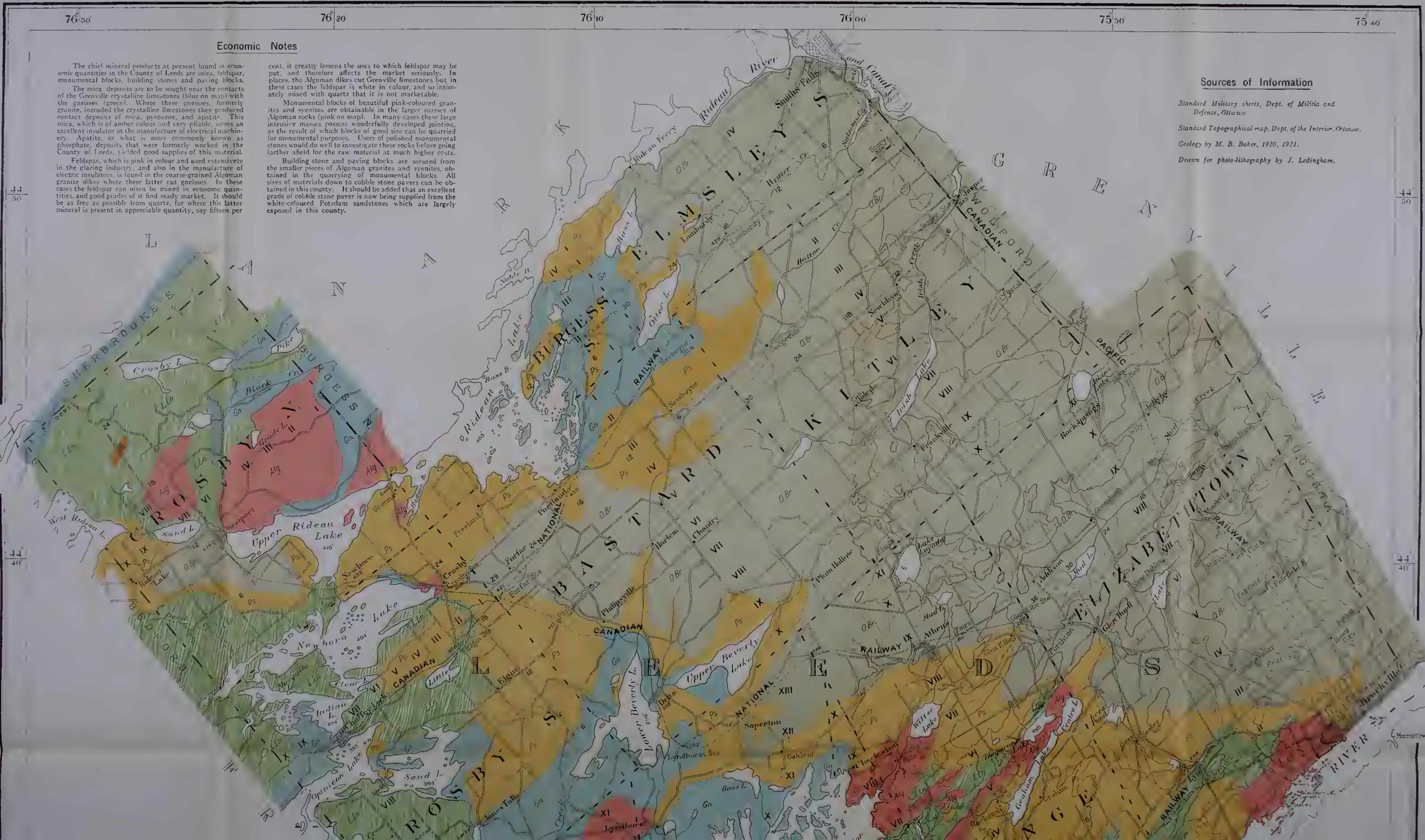
Miles 2 0 2 4 6 Miles

Gov.Doc
Ont.
M
TN
27
O6A33

31 (1922) pt 2-10

Map Nº 31c

COUNTY OF LEEDS



Economic Notes

The chief mineral products at present found in economic quantities in the County of Leeds are mica, feldspar, monumental blocks, building stones and paving blocks.

The mica deposits are to be sought near the contacts of the Grenville crystalline limestones (blue on map) with the gneisses (green). Where these gneisses, formerly granite, intruded the crystalline limestones they produced contact deposits of mica, pyroxene, and apatite. This mica, which is of amber colour and very pliable, forms an excellent insulator in the manufacture of electrical machinery. Apatite, or what is more commonly known as phosphate, deposits that were formerly worked in the County of Leeds, yielded good supplies of this material.

Feldspar, which is pink in colour and used extensively in the glazing industry, and also in the manufacture of electric insulators, is found in the coarse-grained Algoman granite dikes where these latter cut gneisses. In these cases the feldspar can often be mined in economic quantities, and good grades of it find ready market. It should be as free as possible from quartz, for where this latter mineral is present in appreciable quantity, say fifteen per cent, it greatly lessens the uses to which feldspar may be put, and therefore affects the market seriously. In places, the Algoman dikes cut Grenville limestones but in these cases the feldspar is white in colour, and so intimately mixed with quartz that it is not marketable.

Monumental blocks of beautiful pink-coloured granites and syenites are obtainable in the larger masses of Algoman rocks (pink on map). In many cases these large intrusive masses possess wonderfully developed jointing, as the result of which blocks of good size can be quarried for monumental purposes. Users of polished monumental stones would do well to investigate these rocks before going farther afield for the raw material at much higher costs.

Building stone and paving blocks are secured from the smaller pieces of Algoman granites and syenites, obtained in the quarrying of monumental blocks. All sizes of materials down to cobble stone pavers can be obtained in this county. It should be added that an excellent grade of cobble stone paver is now being supplied from the white-coloured Potsdam sandstones which are largely exposed in this county.

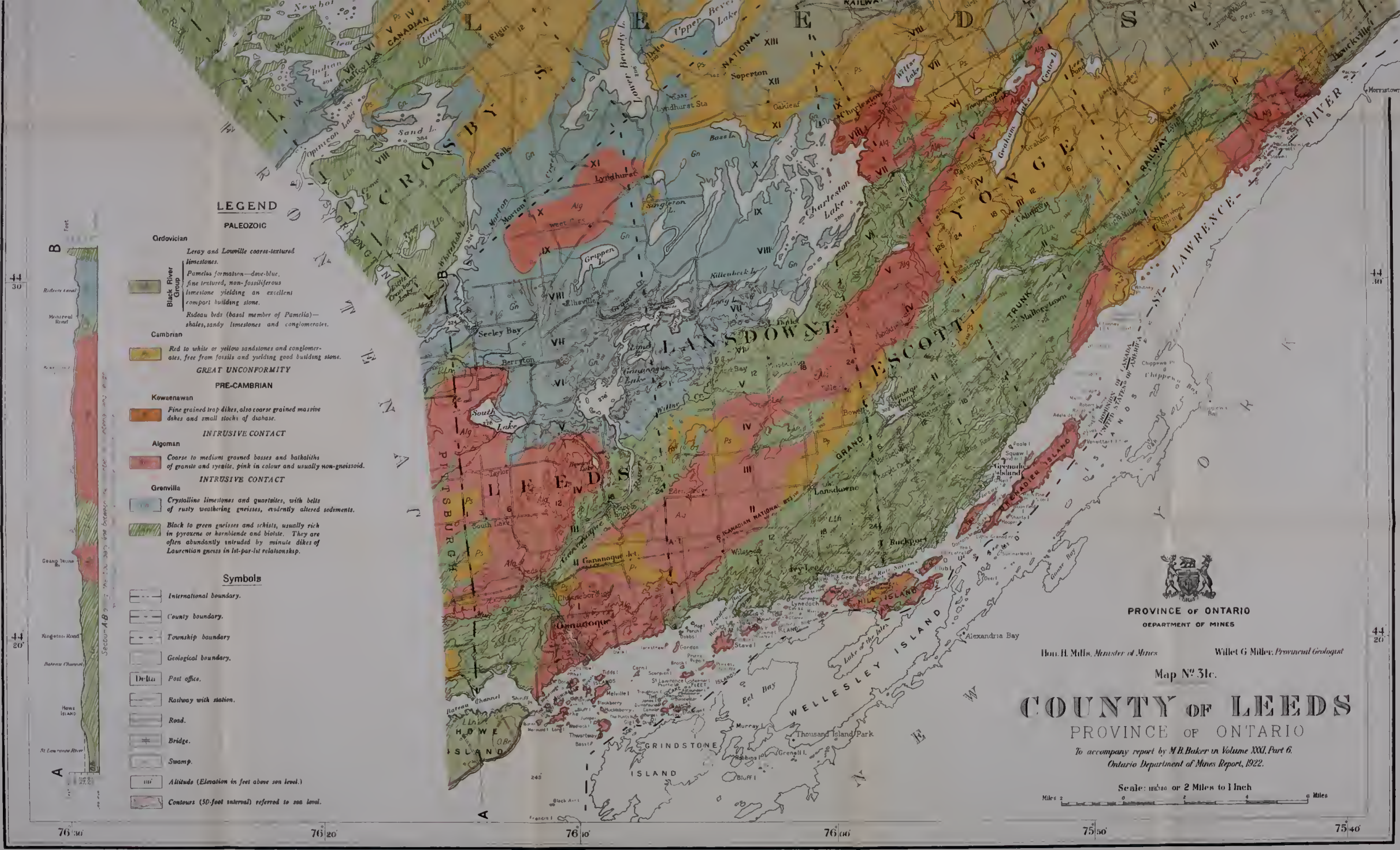
Sources of Information

Standard Military sheets, Dept. of Militia and Defence, Ottawa

Standard Topographical map, Dept. of the Interior, Ottawa.

Geology by M. B. Baker, 1920, 1921.

Drawn for photo-lithography by J. Ledingham.



PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, *Minister of Mines*   Willet G. Miller, *Provincial Geologist*

Map Nº 31c.

COUNTY OF LEEDS
PROVINCE OF ONTARIO

To accompany report by M. B. Baker in Volume XXXI, Part 6.
Ontario Department of Mines Report, 1922.

Scale: 1/126,720 or 2 Miles to 1 Inch

LEGEND

PALEOZOIC

Ordovician

Black River Group:
- *Leray and Lowville coarse-textured limestones.*
- *Pamelia formation—dove-blue, fine textured, non-fossiliferous limestone yielding an excellent compact building stone.*
- *Rideau beds (basal member of Pamelia)—shales, sandy limestones and conglomerates.*

Cambrian

Ps — *Red to white or yellow sandstones and conglomerates, free from fossils and yielding good building stone.*

GREAT UNCONFORMITY

PRE-CAMBRIAN

Keweenawan

Fine grained trap dikes, also coarse grained massive dikes and small stocks of diabase.

INTRUSIVE CONTACT

Algoman

Alg — *Coarse to medium grained bosses and batholiths of granite and syenite, pink in colour and usually non-gneissoid.*

INTRUSIVE CONTACT

Grenville

Gn — *Crystalline limestones and quartzites, with belts of rusty weathering gneisses, evidently altered sediments.*

Lln — *Black to green gneisses and schists, usually rich in pyroxene or hornblende and biotite. They are often abundantly intruded by minute dikes of Laurentian gneiss in lit-par-lit relationship.*

Symbols

- *International boundary.*
- *County boundary.*
- *Township boundary.*
- *Geological boundary.*
- Delta — *Post office.*
- *Railway with station.*
- *Road.*
- *Bridge.*
- *Swamp.*
- 110' — *Altitude (Elevation in feet above sea level.)*
- *Contours (50-foot interval) referred to sea level.*

Gov. Doc.
Ont Mines Dept of
Ann Rep
31 (1922) pt 3-10
TN
27
O6A33

Map Nº 31d.

WATABEAG AREA

PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, Minister of Mines.

Willet G. Miller, Provincial Geologist.

NOTES

The Watabeag Area is situated partly in the district of Timiskaming and partly in the newly created district of Cochrane, about 450 miles north of the city of Toronto. Good wagon roads lead from the towns of Matheson, Ramore, Yorkston and Bourkes, stations on the Temiskaming and Northern Ontario Railway, to the eastern portion of the area. Canoe routes shown on the map have all been travelled, and portages re-cut and blazed where necessary.

The discovery of gold in Playfair township ranks among the first in point of time in northeastern Ontario. Claims were also staked for gold in the townships of Egan, Timmins and Terry more than a decade ago, but so far no production has come from the area. At present only a few mining claims have been staked in any of the townships, and the area has received little or no attention from the prospector since 1910.

The area is from 850 to 1300 feet above sea level. The only area of agricultural lands of important size is in the townships of Playfair, Egan, western McCann and eastern Sheraton.

Much of the forest, particularly in Playfair and in the sand country, has been burned and re-burned, yet much valuable timber still remains.

The magnetic declination within the area varies usually between 9° and 11° west of north. Some variations from this have been noted on the map.

Geology

The legend accompanying the map gives the rock relationships as recognized in the field. Only field names are used on the map, as the reconnaissance nature of the report did not warrant a more intensive study or microscopical classification.

The following is a brief description of the rocks beginning with the oldest:—

Keewatin.—The Keewatin rocks in the area are considered to be an orderly succession of lava flows, basic for the most part, consisting of amygdaloidal pillow lavas, and fragmental material. These rocks, remote from the batholithic intrusion of granite are generally massive, schistosity being only local. The rocks about the periphery of the granite batholith have been largely altered to hornblende, chlorite and sericite schists, the first named predominating. Other Keewatin rocks are serpentine, rhyolite, and a heterogeneous clastic fully described in the text.

Algoman.—The central and western fringe of the area is occupied by a granite batholith, with syenite porphyry facies. Granite gneiss occurs locally throughout the area occupied by the batholith. Surrounding the batholith, many granite, syenite and acid porphyry dikes intrude the Keewatin rocks.

Matachewan.—Dikes and sills of diabase belonging to this age are to be found with a widespread distribution throughout northeastern Ontario. The dikes, definitely of pre-Cobalt series age, are frequently characterized by phenocrysts of labradorite feldspar sometimes one or two inches in diameter. The phenocrysts have a greenish yellow waxy appearance, due principally to sericitization and kaolinization. Other diabases which petrographically are practically identical with the Nipissing diabase are also found. The dikes usually strike in a northerly direction. The name has recently been given to the series by A. G. Burrows who has studied it in both the Matachewan and Gowganda areas.

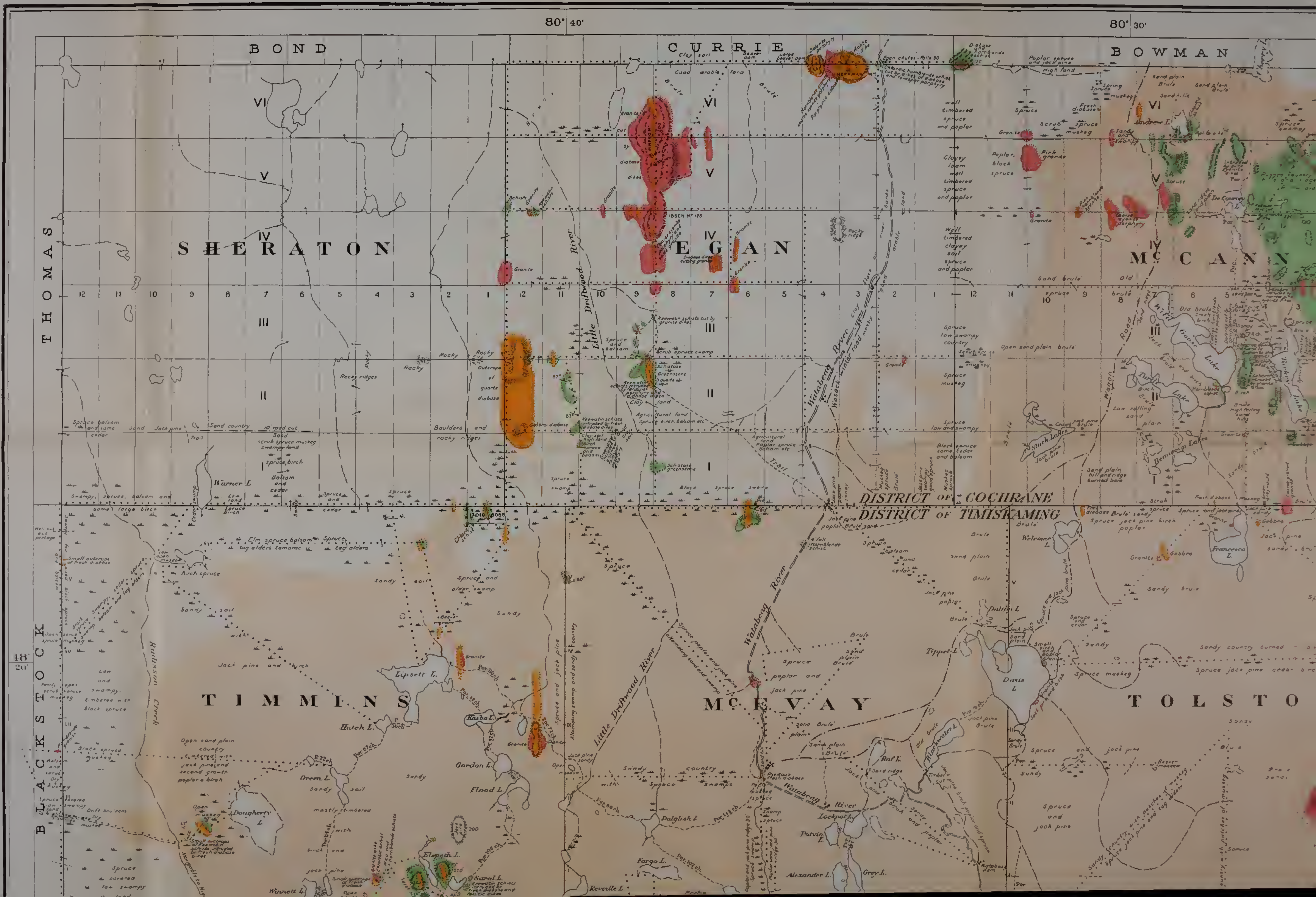
Cobalt Series.—This series is comprised of slate, slate-like greywacké, greywacké and a conglomerate containing boulders of a reddish granite, and usually rests unconformably on either a basic Keewatin or Algoman granite floor. This series in the Watabeag area is not thought to be of economic importance, as it is, so far as observed in the field, free from intrusive action from the Nipissing diabase. Being of a later age than the gold-bearing veins of northeastern Ontario, the Cobalt series cannot be expected to contain auriferous deposits. Minor beds of arkose exist, and the sediments of this series are usually characterized by flat lying bedding or stratification.

Nipissing Diabase.—Doubtless some of the fresh diabase dikes and sill remnants intrusive through the Keewatin and Algoman rocks are the correlatives of the Nipissing diabase with which are genetically related the silver ores of Cobalt, Gowganda and elsewhere, and hence are worthy of some note. A little Cobalt bloom was seen in a vein with a calcite gangue on the southwest shore of Radisson lake.

Pleistocene—Superficial deposits of unconsolidated material cover a great part of the area. The drift deposits consist largely of sand, gravel, stratified clay, or sand and clay. The panning of some glacial sands and gravels in the area has resulted in a few colors of gold to the panfull. Since the sand and gravel is purely of glacial origin, there is little chance of a natural concentration having been effected to a sufficient extent to form deposits of economic importance.

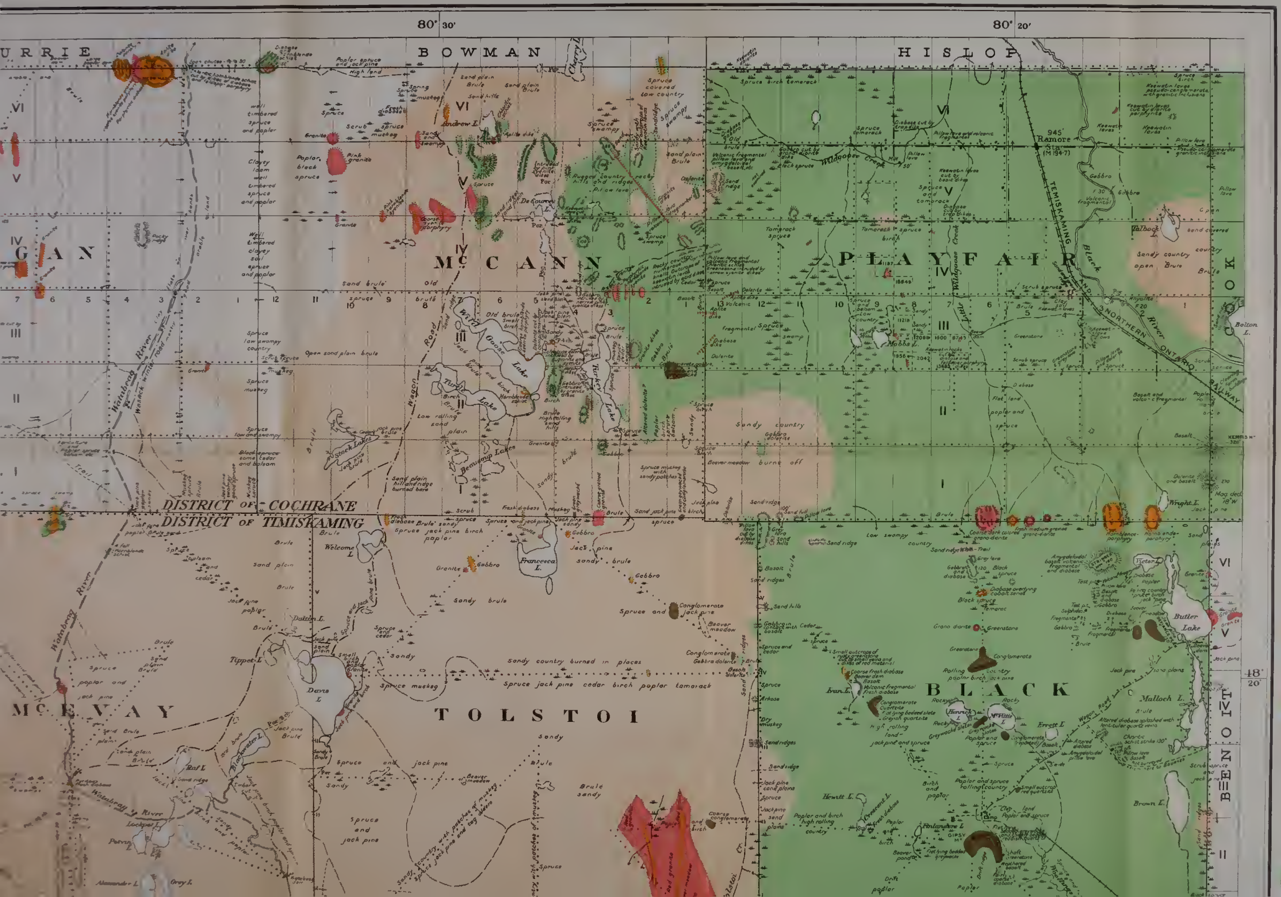
Economic Geology

Speaking generally from an economic viewpoint the geological work proved disappointing, for much of the area is both overlain by swamps and sandplain and underlain by hornblende granite. The Keewatin rocks near the margin of the granite batholith are favourable for prospecting.



PROVINCE OF ONTARIO
DEPARTMENT OF MINES

Hon. H. Mills, Minister of Mines. Willet. G. Miller, Provincial Geologist.



Economic Geology *(continued)*

Gold.—Gold discoveries have been made at several points in the area, notably in Playfair, Timmins and Terry townships. The discovery of gold in Playfair township was practically the first in northeastern Ontario. The Ontario land survey party working in Playfair township first noticed the occurrence in 1905 and the news soon spread. Claims were staked by Messrs. Mercer, Mobbs, Legris, Tabicoe, Gould and others, early in the spring of 1906

The discovery of gold in 1908 along the south boundary of Terry township in the Fall Duck lake vicinity led to a mild rush to that part of the area. This was known as the "Caribou Rush" of 1909. Other gold discoveries have been made, but no work has been done in late years on any of the discoveries

While the economic importance of the gold deposits so far discovered in the area is still quite problematical they at least afford another striking example of gold being derived from acid intrusives of Algoman age This relationship is particularly well exemplified by the occurrence of gold in a pegmatitic vein in the granite on Bierderman claim, D. G 67, in Terry township. All gold discoveries to date, in the area, are in close proximity to the granite, syenite or feldspar porphyry, all of which are considered to have a genetic connection being different facies of the same parent magma In the proximity of these acid intrusions is a favourable locality to prospect for gold. Ontario's gold bringer an extensive batholith of Algoman age, occupies a goodly proportion of the area, and around the periphery of this batholith is a favorable locality in which to prospect for gold deposits. The first prerequisite for gold ore deposition is dynamic disturbance; the second essential factor is intrusive action of Algoman age. The most favourable structure in Ontario so far as present developments lend a key is either synclinal or anticlinal folding. These regional folds are "ear marked" for the prospector by either an infolded remanent of the Temiskaming sediments, as is the case in the Porcupine, the Kirkland Lake and the Matachewan gold camps, or by prospecting in a Keewatin country where the structure is revealed by the upturned surfaces of lave flows. For a more comprehensive understanding of these, that they may be recognized in the field, the prospector should have reference to either or both of the following reports of the Ontario Department of Mines:

(1) "Abitibi-Night Hawk Gold Area," Vol. XXVIII, 1919, Pt. II.

(2) "Black River Area, Vol. XXX, 1921, Pt VI

Synclinal or anticlinal structure would be denoted in an area by the flow tops facing south at one point and north at another not widely separated point The usual trend of the lava flows is nearly east and west. The application of this index to structure might lead to the discovery of deposits of economic importance.

LEGEND

Glacial and Recent

⬜ *Stratified clay, boulder clay*

▨ *Sand and gravel.*

UNCONFORMITY

PRE-CAMBRIAN

Keweenawan (?)

🟧 *Quartz diabase and [illegible] (Keweenawan ?)**

Cobalt series.

🟫 *Conglomerate, greywacke, [illegible] slate-like greywacke and arkose.*

UNCONFORMITY

Algoman.

🟥 *Granite, gneissic in places, [illegible] syenite porphyry, granite porphyry and aplite and lamprophyre dikes*

INTRUSIVE CONTACT

Keewatin.

🟩 *Rhyolite, dacite, andesite, basalt, [illegible] canic fragmental, pseudo-conglomerate, old diabases and gabbro [illegible]* the sediments of this series are usually characterized by flat lying bedding or stratification.

Nipissing Diabase.—Doubtless some of the fresh diabase dikes and sill remnants intrusive through the Keewatin and Algoman rocks are the correlatives of the Nipissing diabase with which are genetically related the silver ores of Cobalt, Gowganda and elsewhere, and hence are worthy of some note. A little Cobalt bloom was seen in a vein with a calcite gangue on the southwest shore of Radisson lake.

Pleistocene—Superficial deposits of unconsolidated material cover a great part of the area. The drift deposits consist largely of sand, gravel, stratified clay, or sand and clay. The panning of some glacial sands and gravels in the area has resulted in a few colors of gold to the panfull. Since the sand and gravel is purely of glacial origin, there is little chance of a natural concentration having been effected to a sufficient extent to form deposits of economic importance.

Economic Geology

Speaking generally from an economic viewpoint the geological work proved disappointing, for much of the area is both overlain by swamps and sandplain and underlain by hornblende granite. The Keewatin rocks near the margin of the granite batholith are favourable for prospecting.

Geologically the area is more favourable as a possible gold producer than for any other mineral. Gold discoveries have already been made at several widely distributed points in the area, viz: in Playfair, in Terry, in Egan and in Timmins townships.

Small deposits of fluorite have been found in Cairo and Alma townships in the eastern part of the Matachewan gold area. They occur in quartz veins in syenite. Since the syenite of the Watabeag area is thought to belong to the same batholith, and owing to the widespread occurrence of fluorite in the area contiguous to the south, prospecting might be rewarded by the finding of economic deposits of this mineral. Small quantities of fluorite were seen in a quartz vein on the west shore of Radisson lake near the bay.

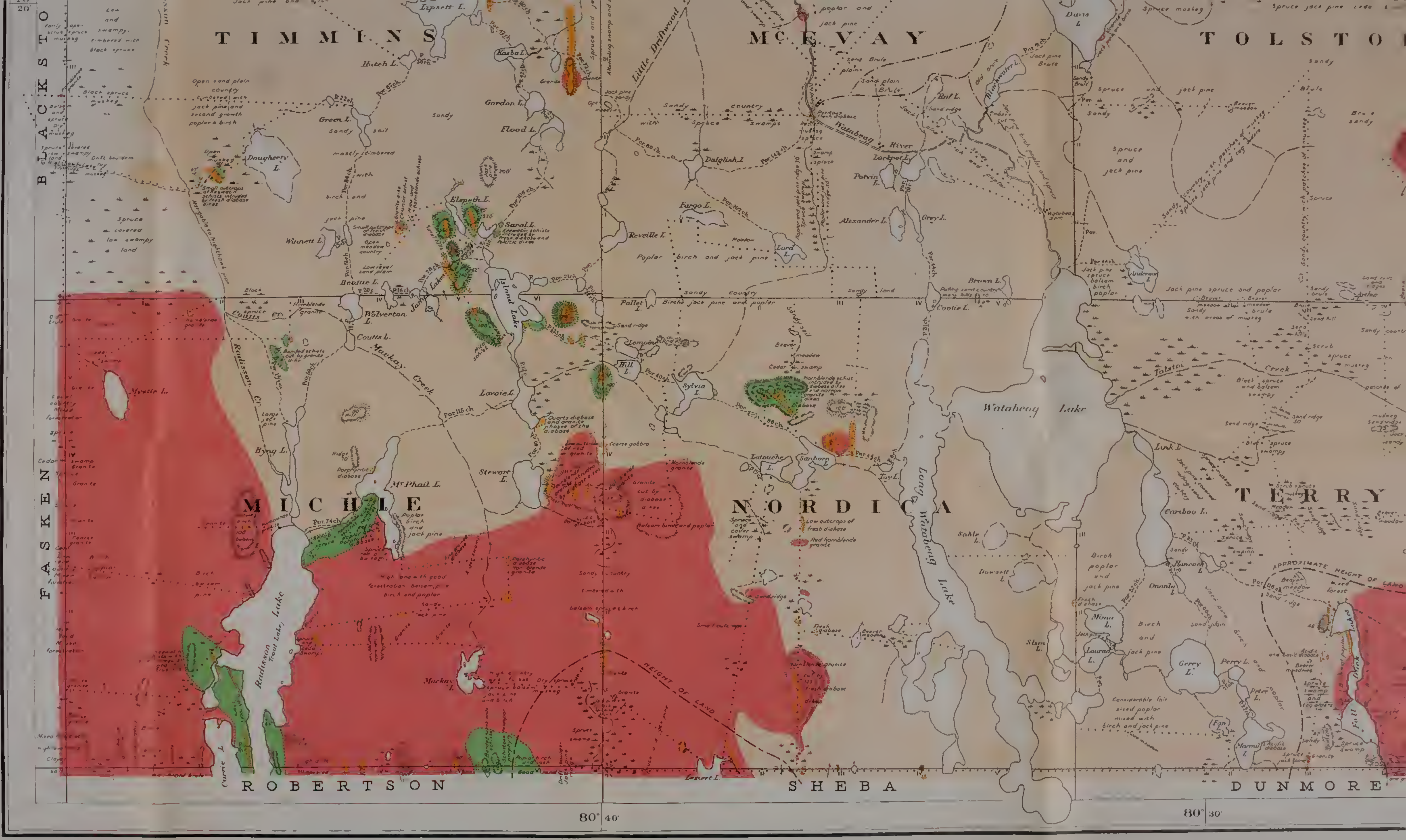
Barite veins of commercial importance have been found cutting the red syenite in one instance, and the Cobalt series, slate and quartzite, in another, in the Matachewan area. There is a possibility of making similar discoveries in the Watabeag area.

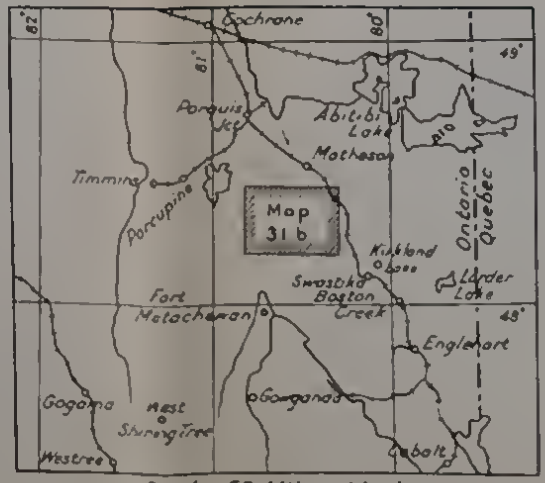
Iron. On the southern boundary of lot 12, concession II, Egan township, there is a small deposit of magnetite, with a minor quantity of chalcopyrite occurring as a magmatic differentiate from the post-Algoman diabase. Some of the chalcopyrite exposed to weathering conditions is altered to the blue basic cupric carbonate, azurite. The outcrop at the point of concentration of the magnetic is quite small, but the diabase appears to underlie the whole lot and appreciable local attraction was noted in this locality. It was, therefore, deemed advisable to mention this occurrence, since differentiation from similar magma has in other areas yielded deposits of economic importance. Complementary dikes, further evidence of magmatic differentiation, were noted in the same locality. Several specimens taken from the outcrop were tested for chromium with negative results. Titanium is present.

Copper. Copper-bearing minerals, principally chalcopyrite, were observed in numerous localities throughout the area, but in no place was a deposit of sufficient extent seen to be of commercial value. In the area chalcopyrite occurs usually in a quartz gangue as small aggregates or minute disseminations throughout the fresh diabase or aplite dikes, genetically connected with the diabase.

Molybdenite. —Molybdenite was seen in a pegmatitic dike in the granite on the Bierderman claim, D. G. 67, on the south boundary of Terry township, and also on claim 17010 on the north boundary of Timmins township. The Timmins township occurrence is at the margin of a quartz vein 16 inches wide, striking S. 80° W., and dipping 60° north. In both instances cited the quantity of the mineral is small.

Erythrite (Cobalt Bloom). Cobalt bloom was identified by the writer from a narrow calcite vein in proximity to the diabase dike which strikes in a northerly direction from the Radisson-Currie lake portage. The quantity was too small to be of economic importance, but at the same time it points to calcite veins in the vicinity of the diabase dikes and sill remnants being worthy of attention as possible sources of silver. This mineral, cobalt boom, has to date in the Province been found with Keweenawan (Nipissing) basic intrusions, with which are also associated the silver, nickel, and arsenic of Cobalt, and elsewhere in the Province.





Scale. 50 Miles = 1 Inch

Map Nº 31 d.

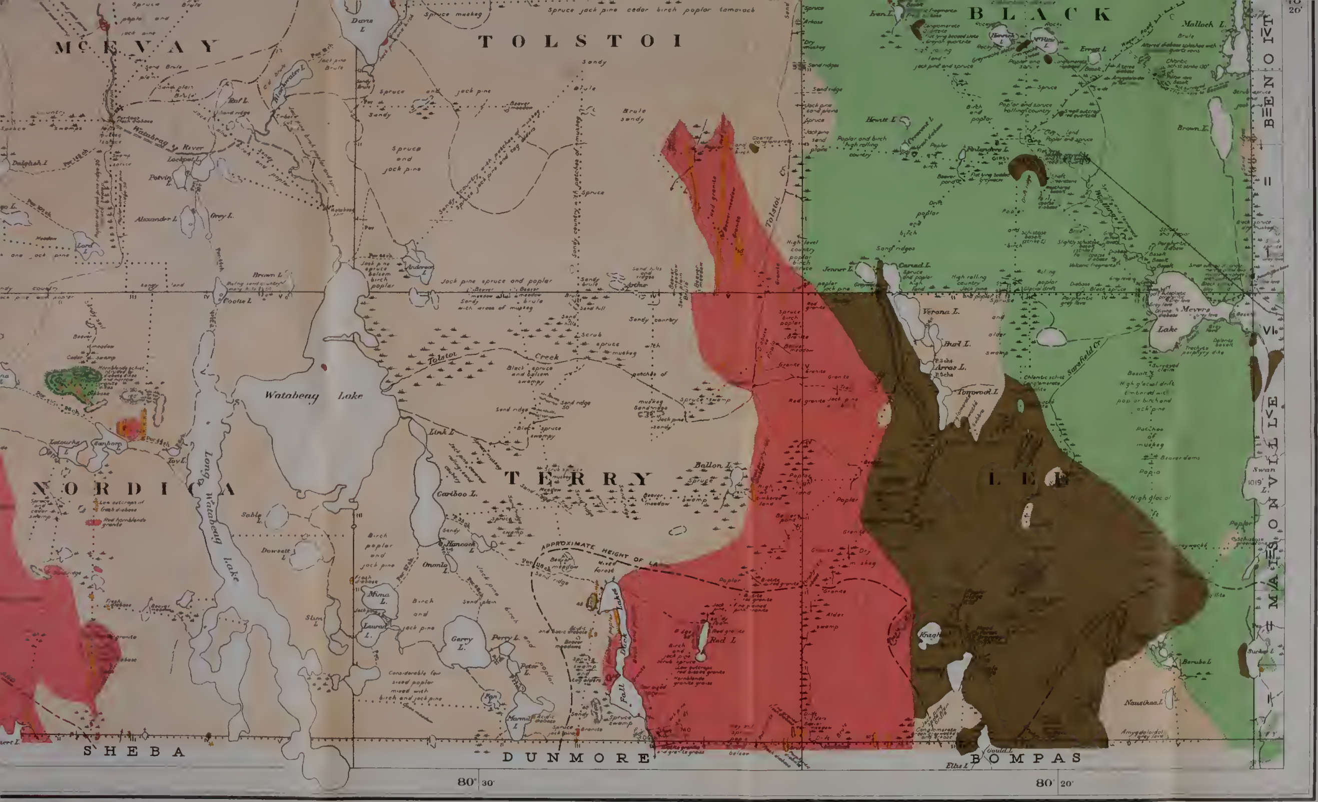
WATABEAG AREA

DISTRICTS OF TIMISKAMING AND COCHRANE, ONTARIO

To accompany report by D.G.H.Wright in Volume XXXI, Part 7, Ontario Department of Mines Report, 1922.

Scale : $\frac{1}{63{,}360}$ or 1 Mile = 1 Inch

Chains 80 40 0 1 2 3 4 Miles



Keweenawan (?)

🟧 *Quartz diabase and olivine diabase (Keweenawan?)**

Cobalt series.

🟫 *Conglomerate, greywacke, argillite, slate-like greywacke and arkose*

UNCONFORMITY

Algoman.

🟥 *Granite, gneissic in places, syenite, syenite porphyry, granite porphyry and aplite and lamprophyre dikes*

INTRUSIVE CONTACT

Keewatin.

🟩 *Rhyolite, dacite, andesite, basalt, volcanic fragmental, pseudoconglomerate, old diabases and gabbros, meta basalt hornblende, chlorite and sericite schists.*

**NOTE. Certain diabase dikes which are considered to be of Matachewan age have not been differentiated on the map from the Keweenawan*

Symbols

Geological boundaries

945 *Altitude (Elevation in feet above sea level.)*

270 *Elevation in feet above general level*

Hill or mountain

Swamp

Road

Trail or portage

● *Building*

The heavy dotted lines indicate the locations of the exploration traverses made during the examination of the rocks. They were run by compass and the distance measured by pacing. The positions of these traverses are shown so that prospectors and others will know exactly what parts of the area have been examined.

Sources of Information

Geology by D. G. H. Wright, 1921.

Topography from plans of surveys from the Department of Lands and Forests, Ontario, also compass and micrometer surveys by D. G. H. Wright and assistants

Map No 28b. Abitibi-Night Hawk Area, by C. W. Knight, A. G. Burrows, P. E. Hopkins and A. L. Parsons, 1919

Map No 30c—Black River Area by D. G. H. Wright, 1921

Map No 31 d.

WATABEAG AREA

DISTRICTS OF TIMISKAMING AND COCHRANE, ONTARIO

To accompany report by D.G.H.Wright in Volume XXXI, Part 7, Ontario Department of Mines Report, 1922.

Scale : $\frac{1}{63,360}$ or 1 Mile = 1 Inch

Chains 80 40 0 1 2 3 4 Miles